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APPROPRIATE WATER AND SANITATION TECHNOLOGIES FOR INDIAN COMMUNITIES IN NORTHERN ONTARIO

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J.E.J. FAHLGREN, COMMISSIONER

APPROPRIATE WATER AND SANITATION TECHNOLOGIES FOR INDIAN COMMUNITIES IN NORTHERN ONTARIO

by

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"Appropriate Technology reminds us that before we choose our tools and techniques we must choose our dreams and values, for some technologies serve them, while others make them unobtainable."

Tom Bender from RAIN Journal of Appropriate Technology

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Contents

Introduction

This 3 month investigation by Pollution Probe was funded by the Royal Commission on the Northern Environment.

The purpose of the study is to bring to attention existing appropriate water and sanitation technologies, as well as to generate some new ideas which require subsequent testing as pilot projects.

A trip to Big Trout Lake and Kasabonika provided meaningful insights into the needs and desires of the Native people living here. The helpfulness and hospitality of the residents of these two communities, particularly of the two families that permitted me to live with them, made this project extremely satisfying.

Scope

This study concerns itself with Indian communities (about 35) in that region of Ontario north of 50°Lat.

The study focuses primarily on water and sanitation problems and improvements for Native homes.

1. APPROPRIATE TECHNOLOGY

1.1 Introduction

"Appropriate technology is a necessary response to the need to bring about a more just and workable society, using careful tools, techniques, and processes which mediate between the human social system and the natural environment to bring long-term stability, adaptability, and life-enhancing prospects for both. It is fundamentally different in approach, not just a new package of available technology".[1]

Appropriate Technology has its origins in the realization that our biosphere can no longer accomodate our growth economy based on one-time use of non-renewable resources and degradation of our renewable resource base.

"The reality and gravity of the environmental crisis can no longer be denied.

We have begun to understand in our bones that whatever the causes of this particular crisis, there might not always be enough material and energy to support even current levels of consumption, much less the higher levels many aspire to".[2]

We are just beginning to learn the importance of developing a more integrated and steady-state relationship between the man-made and the natural environment.

Western society in its 'civilized' state has so divorced itself from the natural environment that it has become impossible to perceive the impact of our individual actions on the environment.

Native people, however, have until very recently lived within the constraints of their environment. Over-consumption and waste are not part of their culture. How could it be when the effect of such action would surely be felt in the immediate future?

The wisdom acquired from centuries of living within the constraints of the natural environment is under threat of being lost from their culture.

White man, sometimes well-meaning, sometimes opportunistic, infiltrates Native culture with its commodities that promise a more satisfying and leisurely life.

A culture used to doing things in a human energy way is being bombarded with labour-saving devices - and to what end? Jobs are rare....humanly satisfying jobs are even rarer.

[1] What Is Appropriate Technology? J.Yudelson and S.Van der Rym. Office of Appropriate Technology, California. 1976.

[2] Ecology and the Politics of Scarcity W.Ophuls. W.H.Freeman and Company. 1977.

Historically, every individual is responsible in a Native community, and every community is self-sufficient.

Today, our culture has so penetrated Native lifestyle as to make it wholly dependent on our commodities and our values.

Western society clearly must make the transition from a growth economy to a steady state economy operating with in the confines of the biosphere.

This involves better management of renewable resources, greater efficiency and re-use of non-renewable resources, and a gradual shift from dependence on non-renewables to use of renewable resources.

Instead of continuing our one-way economy where resources are used once and released into the environment as contaminants, it is critical that we complete the cycle.

By completing the cycle, the waste product of one process becomes the starting point of another process.

It is equally important to reduce the rate of throughput of materials through our society. By using less and using it better, we facilitate transition to a stable long-term relationship between the man-built and the natural environment.

This knowledge is probably still within the memory of most adult Indians in Northern Ontario today.

'Appropriate Technology' is particularly relevant to Native people because it is rediscovering what Native cultures have known for centuries.

1.2 Appropriate Technology Criteria

The water supply and sanitation technologies which follow in this report are designed to meet certain criteria (see Table 1).

The technologies selected tend to be of a scale small enough to be comprehended and controlled by non-experts. In the case of the drum privy, for example, the biological processes are complex, however the technology to construct and maintain it is simple.

The technologies advocated in this report demand participation of local people. This permits employment opportunities and economic benefits to remain within the community.

By expanding the skills of the local people, the entire community moves toward greater self-sufficiency and autonomy.

Use of local materials spurs greater re-use and conservation of materials. Instead of flying in pre-manufactured commodities from outside the region, introduction of appropriate technologies gradually shifts the site of production from outside the region to within the community.

By minimizing the transport of goods, commodity costs decrease, as does energy demand to transport these goods.

Greater use of locally derived resources, and choosing small scale affordable technologies reduces the costs associated with large scale centralized production of commodities, such as financing, advertising and management charges.

Most important of all, it encourages the development of technologies that meet local needs and lifestyles, rather than requiring local people to meet the demands of technology.

TABLE 1 CRITERIA FOR AN APPROPRIATE TECHNOLOGY

Appropriate	Inappropriate
Ecological	
1. Does not release pollutants or poisons to environment	1. Pollutes/poisons the environment
2. Protects existing natural habitat	2. Destroys natural habitat
3. Restores viability of ecosystems	3. Destroys viability of ecosystems
4. Recycles organic nutrients/ creates topsoil	4. Wastes nutrients and destroys topsoil
5. Produces food	5. Destroys food production (potential or actual)
6. Conserves renewable resources	6. Over-uses renewable resources
Energetic	
7. Conserves nonrenewable resources	7. Uses and wastes nonrenewable resources
8. Promotes use of renewable energy sources	8. Uses nonrenewable energy sources
9. Promotes use of recycled materials	9. Does not use recycled materials
10. Reduces transportation dependence	10. Increases dependence on transportation
Economic	
11. Long life	11. Short life
12. Low cost (initial and/or lifetime)	12. High cost
13. Promotes small scale production, local ownership, bioregional economy	13. Promotes large-scale centralized enterprises
14. Promotes meaningful work	14. Dehumanizing/impoverishing work or lack of work
15. Labour/skill intensive	15. Capital-intensive
Social/Political/Cultural	
16. Provides human habitat	16. Destroys human habitat
17. Promotes social flexibility and adaptability	17. Reduces social flexibility
18. Promotes self-reliance and community co-operation	18. Promotes centralized control
19. Understandable/usable at community level	19. Understandable to and run by specialists
20. Creates/maintains natural beauty	20. Destroys natural beauty

Source: Criteria For An Appropriate Technology. L.Nelson and J.Yudelson. Office of Appropriate Technology, 1976.

2. THE BIOPHYSICAL ENVIRONMENT

2.1 Climate

The climate of northern Ontario is classified as modified continental (Chapman and Thomas, 1968) resulting in long cold winters and short generally warm summers.

During the winter, cold dry waves of polar continental air move southeastward from the Prairie Provinces or southward from the Arctic. Extended periods of clear cold weather are common in winter.

During the summer months, the weather is more changeable due to interaction of air masses from the Pacific coast, from the south, from the Arctic, from Hudson Bay and from the Atlantic coast. Warm humid air masses from the south interact with cooler drier air from the north to provide increased precipitation during summer months.

The presence of Hudson Bay and James Bay exerts a moderating influence on temperature and precipitation. While the western portion of Northern Ontario is more continental in climate with larger differences between summer and winter air temperatures, coupled with maximum precipitation in the summer, the eastern portion (the Hudson Bay lowlands) experiences the moderating influence of Hudson Bay. The maritime influence of Hudson Bay results in a less extreme temperature and precipitation difference between summer and winter months.

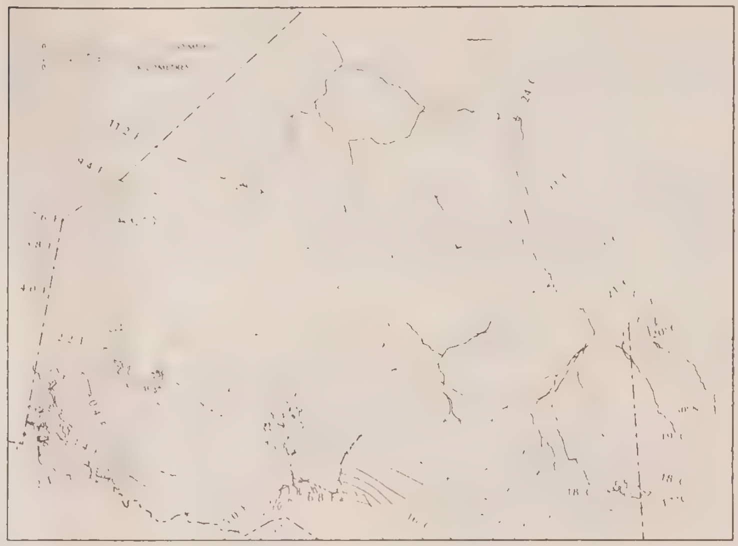
2.1.1 Air Temperature

January tends to be the coldest month in Northern Ontario. Daily mean temperatures in January range from about -19°C at Sioux Lookout (latitude 50°N) to -25°C at Winisk (latitude 55°N).

Air temperatures substantially increase in March with the increasing length of daylight. By April, temperatures exceed the freezing point of water. June, July and August comprise the summer months. July is generally the warmest month. Daily mean temperatures in July range from about 18°C at Sioux Lookout to 12°C at Winisk (see Table 2).

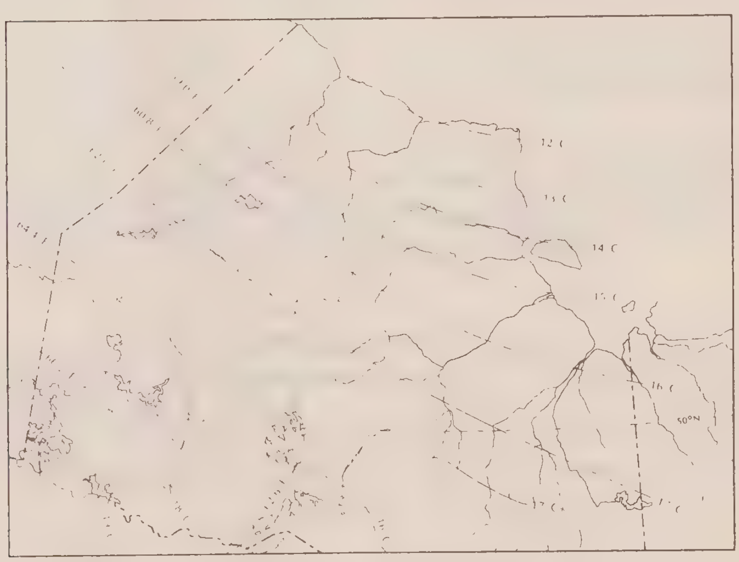
The modifying influence of Hudson Bay is most pronounced during summer (see Maps 1 and 2). The southeastward trend of the July isotherms (lines of same air temperature) on Map reflect the cooling influence of Hudson Bay. In the fall and winter, the Hudson Bay exerts a warming influence.

Map 1 Mean Daily Temperature for January



Source: Issues Report. Royal Commission on The Northern Environment. 1978.

Map 2 Mean Daily Temperature for July



Source: Issues Report. Royal Commission on The Northern Environment. 1978.

TABLE 2 DAILY MEAN AIR TEMPERATURE (°C)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
WINISK[1]	-25.3	-24.0	-19.3	-9.3	0.8	7.1	11.7	11.2	7.2	1.1	-8.2	-19.2
BIG TROUT[2]	-24.1	-21.6	-14.4	-4.4	3.6	11.6	15.9	14.4	8.6	2.2	-9.0	-19.6
LANSDOWNE[2]	-22.4	-19.4	-12.5	-2.6	5.4	13.3	17.1	15.3	9.6	3.3	-7.5	-17.9
MOOSONEE[1]	-20.6	-18.0	-11.9	-2.5	5.2	11.9	15.6	14.9	10.0	3.9	-5.4	-15.4
SIOUX LOOKOUT[2]	-18.7	-15.8	-8.1	1.3	8.6	15.0	18.4	16.9	10.9	5.2	-5.2	-14.7

1 Permafrost Investigations in North Ontario and Northeastern Manitoba. R.J.B.Brown. National Research Council, Ottawa. 1968.

2 Canadian Normals: Temperature (1941-1970). Environment Canada, Downsview. 1975.

Daily temperature variation throughout the year generally is 9 to 12°C. Temperature variation from day to night is somewhat greater in March (~13°C) and somewhat less in November (~7°C) (Ministry of Natural Resources, 1978).

2.1.2 Growing Season

Growing season is generally considered to begin and end at the average date of occurrence of an air temperature of 5.5°C. At the begin of the growing season, night time and day time temperatures may range from 0°C to 12°C.

At 50°N, the growing season commences in the first two weeks of May and ends midway in October. Here the growing season may extend for 160 days (Royal Commission on the Northern Environment, 1978).

At the more northerly latitudes, the growing season rarely exceeds 130 days, starting late in May and continuing through September (Ministry Natural Resources, 1978).

2.1.3 Permafrost

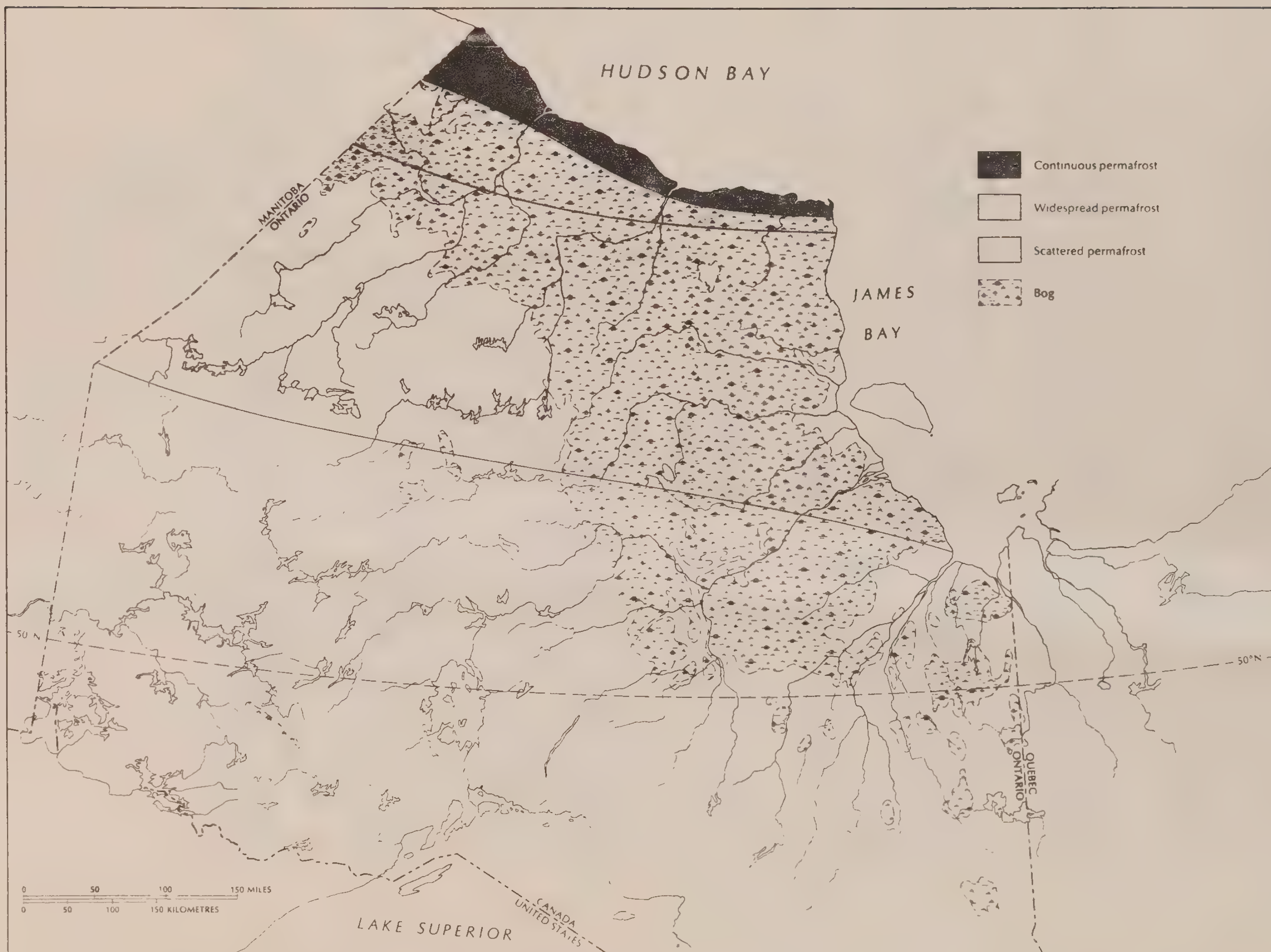
Ontario north of 50° latitude is located almost entirely in the discontinuous permafrost zone (see Map 3). Only the northern most strip along the Hudson Bay coast lies within the continuous permafrost zone.

Patches of ground frozen year-round ranging in size from less than 15 meters to several acres occur in the discontinuous permafrost zone. At the southern limit of the permafrost zone, patches of ground may be frozen perennially from a few centimeters to half a meter (Brown, 1968). In the northern portion of the discontinuous zone, permafrost patches are much deeper. Thompson, which is located at the southern edge of widespread permafrost zone in Manitoba reports frozen ground more than 15 meters down (Brown, 1968).

Unfortunately, widespread information is lacking on permafrost depth in northern Ontario.

Areas of permafrost in the discontinuous permafrost zone usually occur in peat bogs (Brown, 1968).

Map 3 Permafrost and Bog



Source: Issues Report. Royal Commission on the Northern Environment. 1978.

2.1.4 Precipitation

In northern Ontario, total annual rainfall and snowfall decrease from the southeast to the northwest (see Map 4,5). Total annual precipitation north of 50° latitude is less than for southern Ontario.

Mean annual precipitation varies from 520 mm in Winisk to 597 in Big Trout Lake to 742 mm in Sioux Lookout. Precipitation is highest during the summer months, particularly in July (see Table 3,4),when it comes down as rain.

Generally, November and December experience the greatest amount of snowfall. Snow remains on the ground throughout November to April. Although small amounts of snow occur in May and October, only trace amounts fall during June, July, August and September.

Normal monthly depth of snow on the ground during winter tends to be less than one meter (Brown, 1968).

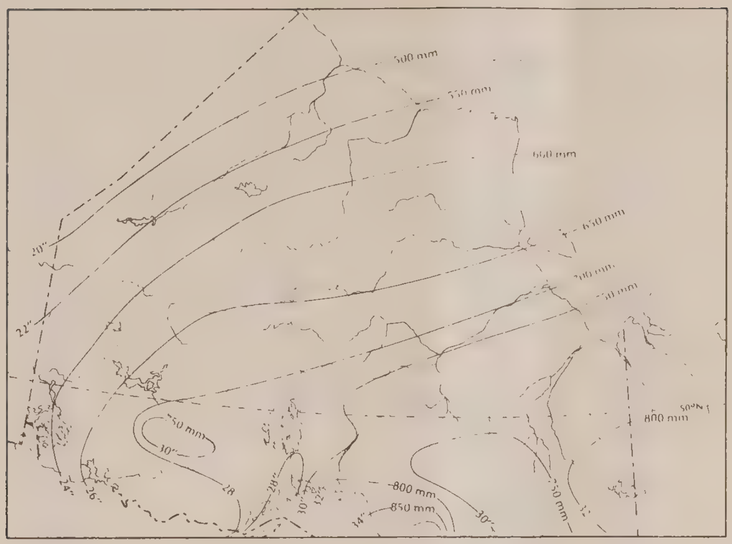
2.1.5 Hours of Daylight

The more northerly the latitude, the greater the duration of sunlight in the summer. At Sioux Lookout (50°N), maximum hours of daylight occur during June, peaking at 16 1/2 hours of light. At Fort Severn (56°N), the most northern community of Ontario, maximum summer daylight is 17 1/2 hours (see Figure 1).

By the beginning of the growing season in May, 14 to 15 hours of daylight are available to plants. At the end of the growing season in September, atleast 12 hours of daylight are still available.

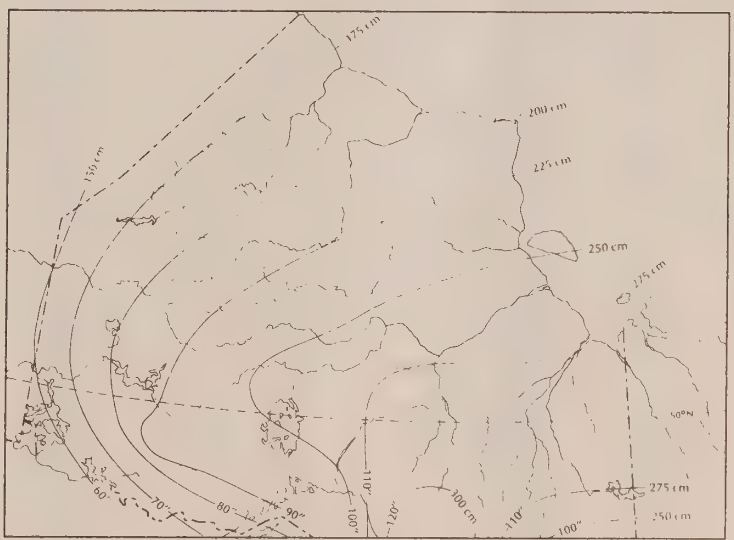
Although the duration of the growing season is shorter than in southern Ontario, the number of hours of summer sunlight available to plants each day is greater than in southern Ontario.

Map 4 Mean Annual Precipitation



Source: <u>Issues Report</u>. Royal Commission on the Northern Environment. 1978.

Map 5 Mean Annual Snowfall



Source: <u>Issues Report</u>. Royal Commission on the Northern Environment. 1978.

TABLE 3 MEAN RAINFALL (millimeters)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
WINISK[1]	<1	<1	<1	<1	23	48	76	71	64	30	9	<1
BIG TROUT[2]	<1	<1	<1	6	30	67	95	86	71	34	3	<1
LANSDOWNE[2]	<1	<1	2	11	40	78	87	74	70	35	6	2
MOOSONEE[1]	2	2	7	19	61	91	80	81	82	55	23	6
SIOUX LOOKOUT[2]	<1	<1	3	19	60	96	96	87	90	48	8	2

1 _Permafrost Investigations in Northern Ontario and Northeastern Manitoba_. R.J.B.Brown. National Research Council, Ottawa. 1968.

2 _Canadian Normals_: _Precipitation_ (1941-1970). Environment Canada, Downsview. 1975.

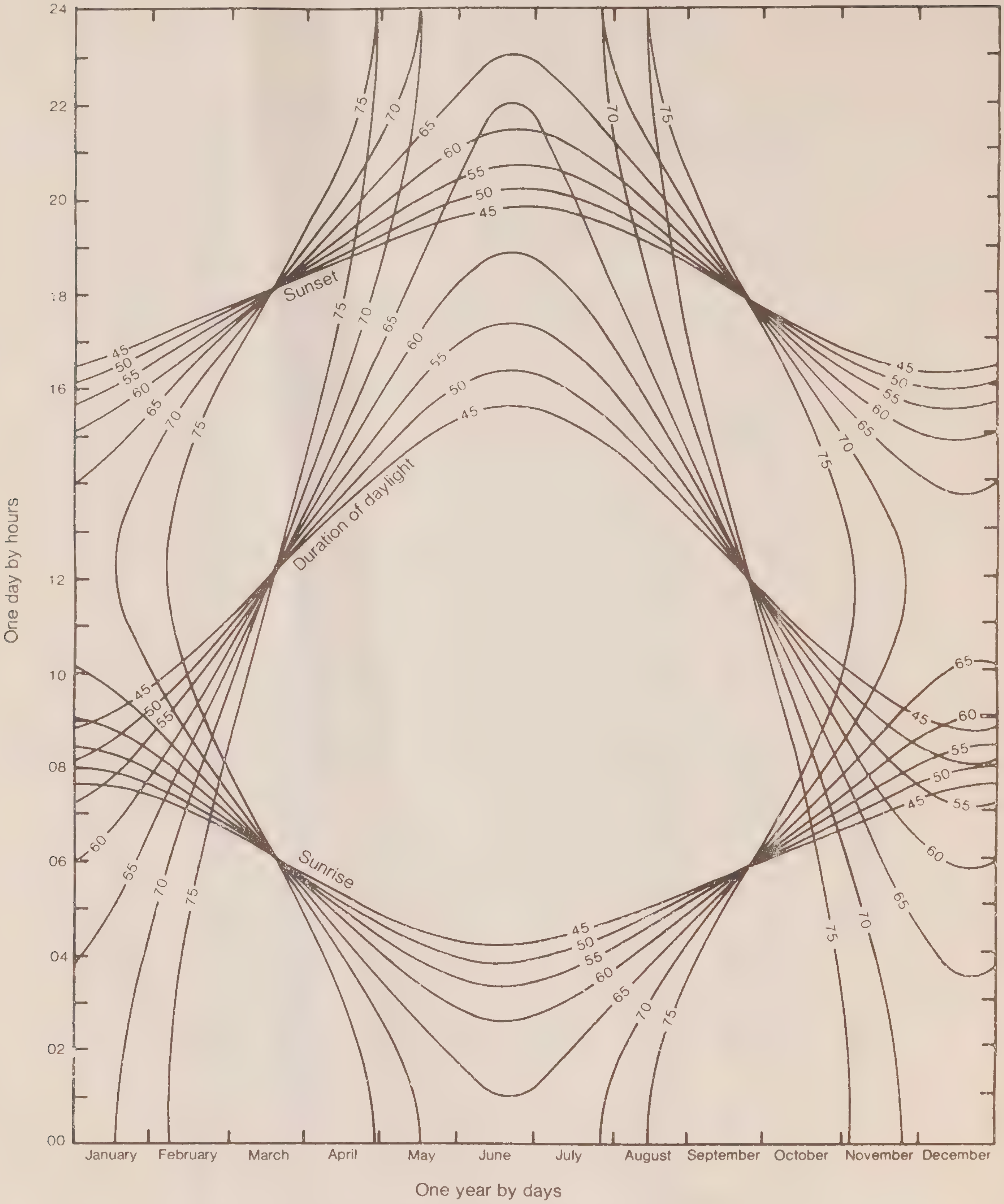
TABLE 4 MEAN SNOWFALL (centimeters)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
WINISK[1]	25	23	23	20	18	3	-	-	3	15	34	38
BIG TROUT[2]	27	22	20	23	19	1	-	-	4	21	45	31
LANSDOWNE[2]	36	26	27	30	14	2	-	-	5	28	40	37
MOOSONEE[1]	46	45	35	25	11	1	-	-	-	18	49	50
SIOUX LOOKOUT[2]	40	30	31	27	9	-	-	-	2	15	48	36

1 Permafrost Investigations in Northern Ontario and Northeastern Manitoba. R.J.B.Brown. National Research Council. Ottawa. 1968.

2 Canadian Normals: Precipitation (1941-1970). Environment Canada, Downsview. 1975.

FIGURE 1 HOURS OF DAYLIGHT AT VARIOUS LATITUDES



Source: Cold Climate Utilities Delivery Design Manual. Economic and Technical Review Report EPS 3-WP-79-2. Water Pollution Control Directorate. March 1979.

2.2 TOPOGRAPHY AND DRAINAGE

2.2.1 Topography

The relief of Northern Ontario ranges from undulating in the Precambrian Shield to flat in the Hudson Bay Lowland.

The Hudson Bay Lowland is comprised of a band of land 100 to 200 miles wide stretching around the coast of Hudson and James Bay. Elevation of this strip of land is less than 500 feet above sea level (see Map 6).

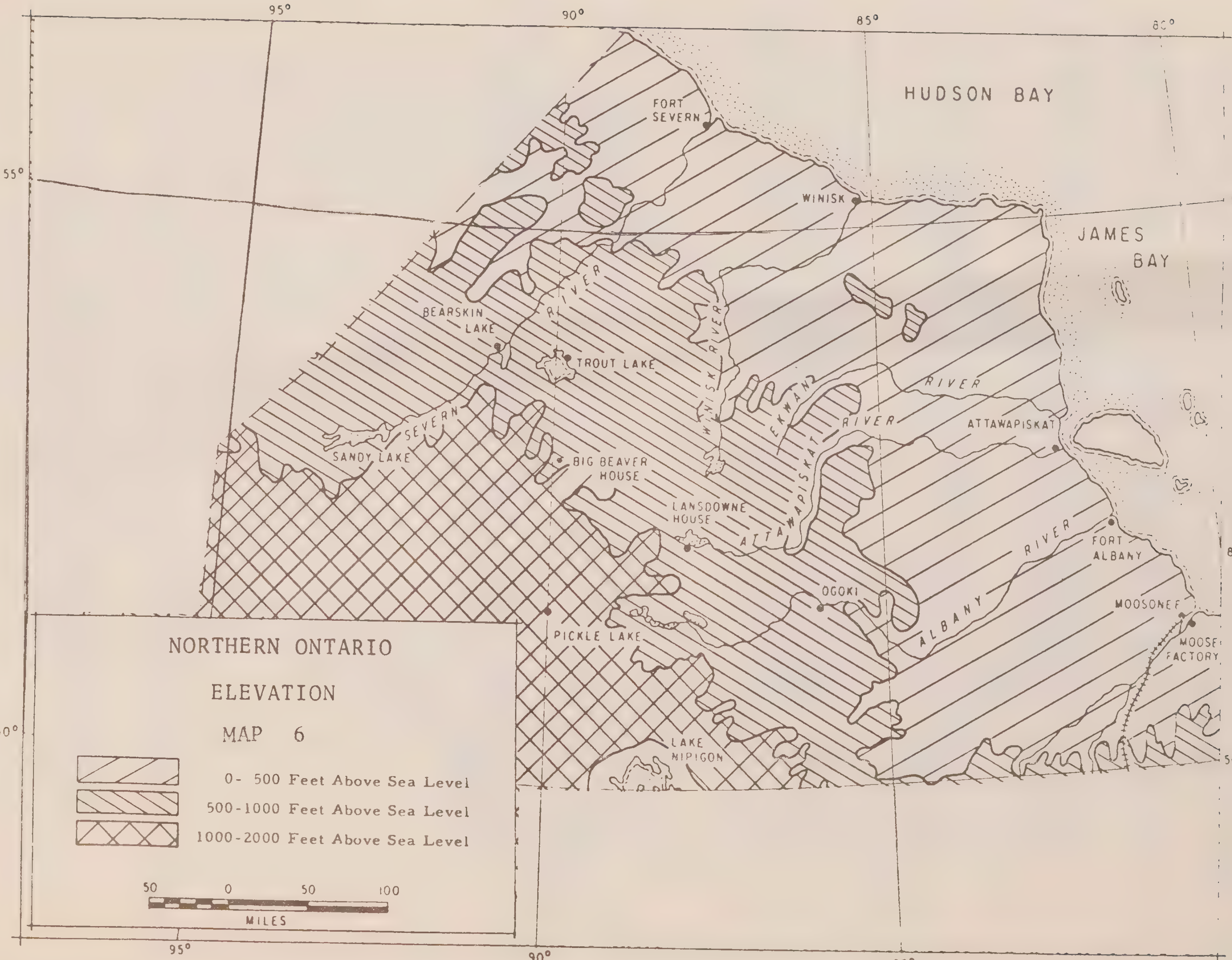
Elevations in the Precambrian Shield gradually increase from 500 feet in the northern portion (at the boundary to the Hudson Bay Lowland) to 2000 feet in the southern portion (at latitude 50°N).

The terrain of the Precambrian shield is characterized by rock outcrops and ridges, peat-filled depressions and numerous lakes. Elevated areas alternate with depressions, ranging in differences of elevation from a few feet to twenty or more. The extent of these low and high areas varies from a few hundred feet to several hundred miles (Brown, 1968).

2.2.2 Drainage

Northern Ontario belongs to the Arctic watershed. The major rivers of this area originate in the shield and flow in a northeasterly direction to Hudson Bay and James Bay.

Water is abundant in northern Ontario. Drainage, usually good on 'high' areas, tends to be poor in the depressions. Bog conditions are prevalent (Brown, 1968).



Source: Permafrost Investigations in Northern Ontario and Manitoba. R.J.E.Brown. NRC 1968.

2.3 SOILS

Detailed information as to soil type, depth, porosity and water table height is generally lacking for Northern Ontario.

Some relatively well drained soils are thought to occur in the Central Plateau region (see Map 7), as well as numerous peat bogs. In most parts of the Precambrian Shield, clay, bedrock and peat bogs predominate. The height of the water table is variable, and often occurs only a few feet below ground surface.

More detailed soil information for some of the Indian communities in Northern Ontario has been extracted from various reports by consultants who dug test holes on site.

Sandy Lake

The predominant soil type is varved clay which extends in depth to more than 19 feet below ground surface. This clay is firm and relatively impermeable to water percolation. In many areas, a surface deposit of peat extends down 6 to 9 feet. In other areas, a shallow (0.5 feet) layer of sand and/or top soil occurred on top of the clay layer.

Generally, the permanent ground water table is located more than 10 feet down. At some test holes, water was found at depths 0 to 10 feet below the surface. It is speculated that this may be due to melting of ice.

Frost is anticipated to extend down 7 feet below ground surface (Dominion Soil Investigations, 1976).

Lansdowne House

The soil is mainly silt till with some sand and gravel. In some areas, the water table is two to three feet below the surface of the ground, however, it is anticipated that the water table generally occurs much lower. Bedrock was not encountered in any of the test holes, however, it is possible that large boulders may exist within the glacial till (UMA Group, 1972).

Grassy Narrows

The soil is predominantly clay. Relatively steep slopes and rock outcrops exist on this site (Proctor and Redfern Ltd., 1974).

Kingfisher

A gravel ridge occurs west of the school. A soil test indicated granular material (UMA Group, 1974).

Big Trout Lake

On Post Island, the soils consist of predominantly a wet clay silt till which is covered by a forest litter of 1 to 3 feet thickness. Soil depth is described as 'shallow' and is underlain by bedrock. Soils are saturated with water in the spring(due to shallow bedrock and clay soil (Jackson et al, 1978).

Deer Lake

Bedrock outcrops are frequent. Soil depth often is shallow. At two test holes, wet silty sand was encountered 2.5 to 3 feet below the surface. The seepage tank of the school is located in an area of very hard clay pan (W.L. Wardrop and Associates Ltd., 1975).

Fort Albany

Heavy organic and clay soils cover most of the site. These soils are not conducive to efficient vertical percolation of water. No bedrock outcrops are visible. Overburden deposit over bedrock is generally from 30 to 80 feet deep (10 to 24 meters) (Crysler and Lathem Ltd., 1979).

Poplar Hill

The depth of the soil in much of the community is shallow and large portions of the village are built on bedrock.

Soil test holes indicate that a 0.5 foot layer of muskeg generally occurs over 3.5 to 4 feet of clay. Some test holes revealed a sandy-clay layer underlain by clay. Silty sand with pebbles occurred in one test hole.

Generally, the water table is high. Soil tends to be saturated with water up to 1 foot below the soil surface.

General percolation into the soil will be poor since the shallow muskeg layer is underlain by clay and sandy silt which is already saturated (W.L.Wardrop and Associates, 1974).

Sachigo

Soils are predominantly clay. The nearest source of gravel and sand is several miles away (Proctor and Redfern, 1974).

Webequie

Shallow (2 foot) test holes indicated 0.5 feet of organic material over a 1.5 foot depth of sandy clay with some pebbles. Another test hole revealed one foot of muskeg underlain by frozen muskeg (W.L.Wardrop and Associates Ltd., 1974).

Fort Hope

Shallow soil and considerable rock (R.J.Burnside and Associates, 1975).

Moose Factory

The surficial layer of top soil is usually 9 to 12 inches in thickness.

This is underlain by loose silt (about 16% fine sand, 74% silt and 10% clay) to a depth of 6.5 to 7.5 feet.

Below the silt stratum, coarser granular material (about 50% sand, 44% silt and 6% clay) was encountered to a depth 16.5 feet below the surface of the ground. The coefficient of permeability of this stratum is 6×10^{-5} cm/sec.

The water table occurs between 6 and 8 feet down (K.H. King Associates Ltd., 1975).

2.4 VEGETATION

Northern Ontario lies within the taiga or boreal forest zone of Canada.

Map 7 divides Northern Ontario into four major forest regions: Central Plateau, Northern Coniferous, Hudson Bay Lowlands and Forest Tundra. Trees are commonly less than 25 feet tall, though some achieve heights of 40 feet. Vegetation within each of these areas is generally as follows: (from Brown, 1968)

Central Plateau

Jack pine is prevalent on the extensive sand and gravel deposits and rocky outcrops. Black spruce are well developed in swamps and especially on better-drained land. At upland sites where soil texture and drainage are better, aspen, white spruce, balsam fir, poplar and white birch occur.

Northern Coniferous

The predominant tree is Black spruce. Some jack pine occurs on the better drained uplands. Tamarack grows in the poorly drained lowlands. White birch occur scattered throughout. Where soil is more favourable, some white spruce, fir, aspen and balsam exist.

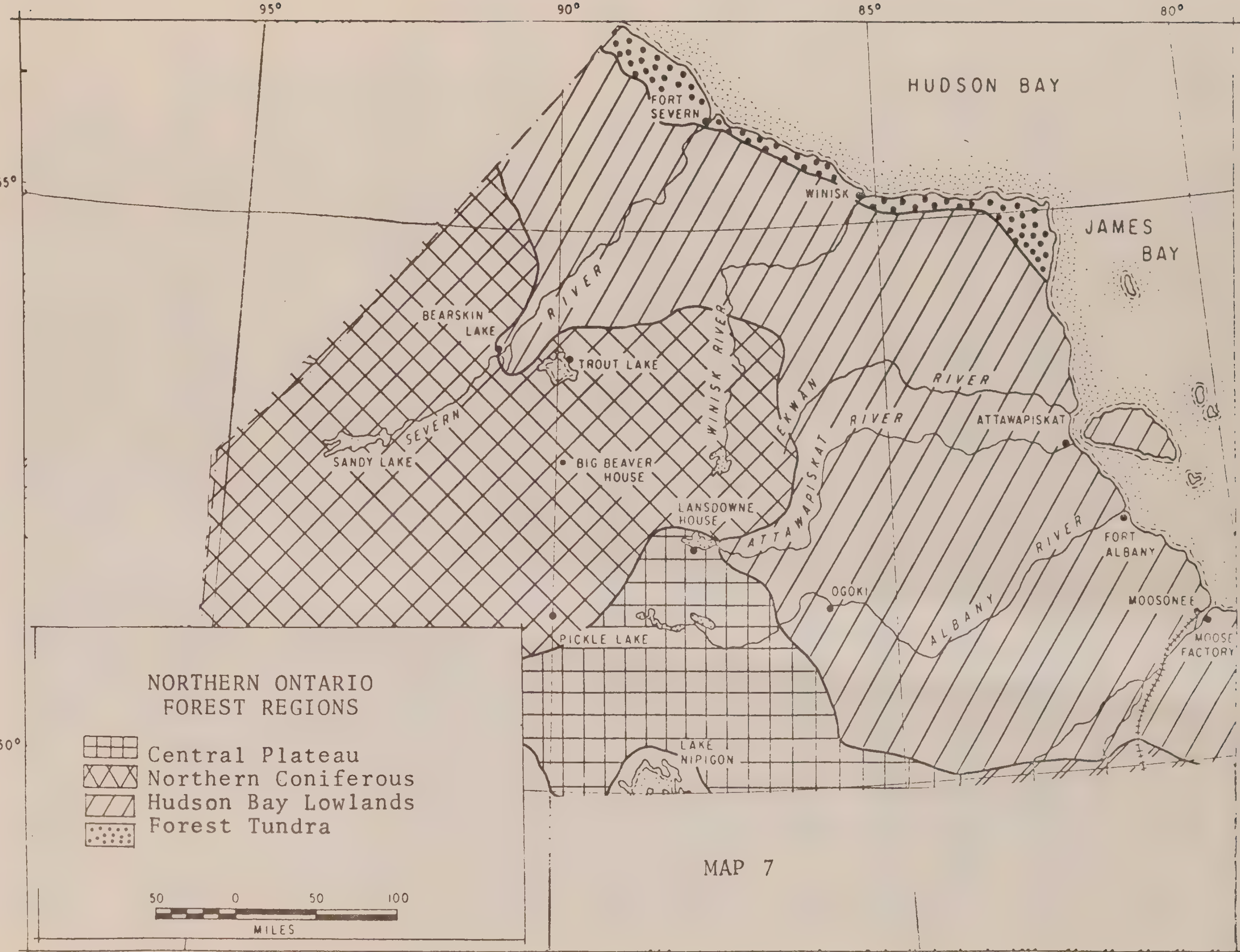
Hudson Bay Lowland

Black spruce and tamarack are the predominant trees in this region. As the percentage of peatland and lakes increases to the northwest, the black spruce and tamarack appear stunted in growth. White spruce, balsam fir, aspen, poplar and white birch occur on river banks where drainage is better.

Forest Tundra

Patches of stunted forest grow on the narrow strip 10 to 50 miles wide along the coast of the Hudson Bay. White spruce, better adapted to a marine environment than black spruce, is the primary tree species. Tamarack, alder and willow shrubs also occur.

Generally low areas are characterized by bog vegetation - open bogs with scattered black spruce growing on thick accumulations of sphagnum and sedge peat. Ground vegetation includes grasses, various berry plants, Labrador tea, club mosses and lichens.



MAP 7

Source: Permafrost Investigations in Northern Ontario and Manitoba. R.J.E.Brown. NRC 1968.

3. INVENTORY OF PRESENT WATER USE AND SANITATION PRACTICES

3.1 Water Supply

Indian communities tend to be located very close to the edge of a lake or river. In most communities, drinking water is obtained directly from this lake or river.

In the summer, water is carried by hand in metal or plastic pails (usually ~ 2 gallon pails). In areas where the lake is perceived to be polluted adjacent to the shore, a boat may be used to obtain water from a less polluted part of the lake.

In the winter, larger containers (plastic garbage cans, canners, 5 gallon plastic jugs etc) are used to collect water since they can be transported on a sled behind a skidoo.

A hole is chopped into the ice, and a clean dipper (metal or plastic) is used to collect water into the large containers.

The drinking water is usually covered with a lid or cloth to keep it clean while stored inside the house.

Before any improvements in water supply are put into effect, it is critical that the desires of the Native community at large, as well as of the Band Council, be determined. For example, although water delivery to each house by a truck and subsequent storage in the home may be viewed as a desired improvement in terms of convenience, it might be discovered later that Native people much prefer to drink fresh water from a lake or river, rather than water that has been sitting in a holding tank for a week.

It must be established on a community by community basis whether improvements in water supply are desired. The community itself must decide whether the alternative proposed is an improvement over the present situation.

In some communities, lake water may be preferred over that from a community well or tap. In other communities, especially those where the lake is perceived to be polluted, chlorinated water from a communal tap may be preferred.

3.2 Water Use

Traditionally native people have not had access to large quantities of water and as a result tend to use water conservatively. However, as water becomes more available, it is used more freely (Water Pollution Control Directorate, 1979).

Generally in Northern Canada, communities without piped water supply, and which do not use water to transport body wastes, use about 4 to 12 L (0.9 to 2.7 gal) water per person per day (Water Pollution Control Directorate, 1979).

In a recent survey at Big Trout Lake (Jackson et al), it was observed that the total amount of water used per capita per day is about 9 to 14 L (2 to 3 gal) (see Table 5).

TABLE 5 WATER USE IN BIG TROUT LAKE - 1978

USE	AMOUNT USED (gallons)	AMOUNT USED (litres)	% OF TOTAL
Drinking	0.3	2	22
Cooking	0.13 to 0.26	0.6 to 1.2	10
Washing dishes	0.13 to 0.26	0.6 to 1.2	10
Daily washing	0.26	1.2	13
House cleaning	0.2 to 0.4	0.9 to 1.8	15
SUB TOTAL	1.0 to 1.5	5.3 to 7.4	70
Laundry	0.57	2.6	30
TOTAL	1.6 to 2.0	8 to 10	100

(Adapted from User's Making Choices. T.Jackson et al. 1978.)

About 22% of the water used is for drinking. Because drinking of tea is popular, especially by adults, much of the drinking water consumed is boiled first.

In the past, Native people were encouraged to purify their drinking water by adding chlorine (Health Committee, Big Trout Lake, 1979). Unpleasant taste, as well as a concern for improper dilution resulted in discontinuation of this practise (Health Committee, Big Trout Lake, 1979).

About 5 to 7.5 L (1 to 1.5 gal) of water are used for drinking, cooking, washing dishes, daily washing and house cleaning. This represents about 70% of the total amount of water used each day.

Laundry is usually done 1 day a week. In Big Trout, use of a washing machine (capacity 20 gal) is common.

Unlike Big Trout, most Native homes in Kasabonika are without electricity, and clothes are washed by hand.

Water is boiled over a wood stove, or, where a hot water tap is available to the community (ie at the Federal facilities), hot water is hauled home to do laundry.

3.3 Excreta Disposal

The overwhelming majority of Indian families make use of outhouses (pit latrines) to dispose of excreta.

The outhouse is located about 10 to 20 feet from the house, and occassionally is seen very close to the water's edge (within 20 feet).

In the summer time, the outdoor privy is used by all. Latrines are reported to smell and attract flies.

During the winter, use of outhouses is variable. In some families, children use a small plastic or metal pail for excreta collection, while the rest of the family still uses the outhouse. The children's diapers and contents of the potty are dumped down the pit of the outhouse.

In other families, a 5 or 10 gallon drum (usually has no toilet seat) located in a separate room within the house is used to collect urine, feces and wastewater from the kitchen during the winter. To prevent the wastewater from smelling, pinesol is added to the drum. Every few days the drum is emptied in the woods or down the pit latrine.

Some families collect urine and kitchen water in a pail. This is dumped somewhat remote from the house, usually in a nearby bush. In such cases, it is preferred to use the outhouse for bowel movements.

Traditionally moss was used as a diaper for babies. This practise has been replaced with the ample use of plastic-lined disposable diapers (Pampers).

Plastic-lined disposable diapers present a garbage problem to most communities. In the words of a member of the Health Committee at Big Trout Lake (personal communication, 1979) "There are more Pampers than snow!".

Addition of diapers to the pit latrine creates problems in that the plastic liner will not decompose. Decomposition of the paper portion is extremely slow and tends to fill the pit, necessitating that the outhouse be moved frequently (ie every year).

Native housing is the responsibility of the band. A certain portion of the capital management plan is allocated to housing each year.

The construction of outhouses, on the other hand, is usually the responsibility of each family (personal communication, Band councillor, Kasabonika , 1979). The construction, maintenance and inspection of outhouses receives low priority.

3.4 Greywater Disposal

Although many native homes have a sink in the kitchen, the drain is not connected to a subterranean pipe system. Usually, a pail is placed under the truncated drain pipe to collect wastewater.

When the pail is full, it is either dumped on the ground around the house, or emptied into a larger slosh bucket for less frequent disposal.

In some Native homes, the kitchen sink is connected to sufficient piping to drain the wastewater to just outside the house.

Daily washing of hands and brushing of teeth occurs in a metal or plastic dish. Sometimes a separate room is set up as a washing area, although more frequently, the personal washing area is part of the kitchen.

Laundry water is commonly emptied on the ground around the house and allowed to drain away over the surface.

3.5 Garbage Disposal

The degree of garbage collection and disposal varies among the different Native communities.

Most of the larger settlements have a community garbage collection service in regular operation. The band operates a garbage pick-up service paid for on a user fee basis.

Sometimes collected garbage is taken to an open pit which is covered once a year. In some communities, the garbage is burned at the dump first and then buried.

In smaller communities, people are encouraged to burn their garbage as far as possible and then bury it in individual garbage pits. Frequently, however, garbage is hauled individually to an area somewhat remote from the community and dumped.

Garbage consists largely of empty cans, paper boxes, metal foil and rags (Canadian British Engineering Consultants, 1975). A relatively small portion of the garbage is easily biodegradable since most fruits and vegetables are purchased in cans.

Garbage storage containers in common use are 45 gallon drums, 5 gallon pails, plastic bags and cardboard boxes. Unless stored securely, dogs rummage through and scatter a large portion of the garbage stored out of doors.

Disposal of waste oil (from diesel or gas engine generators) is a problem. The oil is burnt,or dumped into the bush, or allowed to accumulate indefinitely in 45 gallon drums.

Domestic garbage generated per capita (Native) per day at 7 communities is indicated in Table 6 .

TABLE 6 AMOUNT GARBAGE PRODUCED BY NATIVE PEOPLE

Community	Amount	
	Pounds/capita/day	Cubic feet/capita/day
Pikangikum	0.6	0.9
Sandy Lake	0.7	1.1
Big Trout	0.6	0.9
Fort Severn	0.8	1.2
Fort Hope	0.6	0.9
Lansdowne	0.8	1.2
Kashechewan	0.6	0.9

Source: Adapted from <u>Study of Solid Waste Management at Indian Settlements in Northern Ontario</u>. Canadian British Engineering Consultants. 1975.

The 7 communities sampled produced similar amounts of garbage per capita. In 1975, Native people in Ontario were producing between 0.5 and 0.8 lb garbage/capita/day.

Canadians on the average produce 3 pounds of domestic garbage per capita per day.

As North American consumer habits and products infiltrate Native communities through television, radio, magazines and newspapers, it is anticipated that per capita garbage production will increase significantly.

Because decomposition and weathering rates of garbage are slow in northern climates, the impact (visual and otherwise) of littered garbage will be substantial even though production rates are relatively low.

TABLE 7 PRESENT AND PROPOSED WATER SUPPLY

Community	Population (1978)[1]	Present Water Supply[2]		Proposed Water Supply[2]
		Native	Non-Native	
Angling Lake	168	Individual haul from lake	Pressurized piped water from well	None
Aroland	300	Individual haul	Piped water from well	n.a.
Attawapiskat	811	Individual haul from river & some private wells	Pressurized piped water supply	Extension of piped water to Native homes
Bearskin	273	Individual haul from lake	Pressurized piped water supply	Community water system (wells)
Big Trout Lake	632	Individual haul from lake, taps and wells	Pressurized piped water supply	Community wells and water delivery
Cat Lake	253	Individual haul from lake	Pressurized piped water from lake	Feasibility study planned for community water suppl[y]
Deer Lake	393	Individual haul from lake	Pressurized piped water from lake	None for Native community
Fort Albany	700	Wells not used for drinking water - water carried from Catholic Miss.	Piped water supply from mission	Community piped water supply
Fort Hope	600	Community stand pipes (summer use)	Pressurized piped water supply	Upgrade community water supply
Fort Severn	231	Individual haul from river	Water gallery	Low-cost improvements in supply
Grassy Narrows	583	Band operated water delivery based on user pay principle	Pressurized piped water from a purification plant	Piped water delivery to most Native homes
Islington (White Dog)	800	50+ have water hook-ups & rest by individual haul or Band operated supply	Pressurized piped water from purification plant	Construction program underway to provide piped water supply to most homes

Community	Population (1978)[1]	Present Water Supply[2] Native	Non-Native	Proposed Water Supply[2]
Kasabonika	388	Individual haul from lake	Pressurized piped water supply from lake	None
Kashechewan	810	Community stand pipes (taps)	Pressurized piped water from river	Extend piped water supply to Native homes
King Fisher Lake	223	Individual haul from lake	Pressurized piped water from lake	None
Lac Seul	479	Individual haul from lake	Pressurized piped water from well	Community water supply system (not piped)
Lansdowne House	215	Individual haul from lake	Pressurized piped water delivery	Piped water supply to most Native homes
MacDowell	42	Hand pump & individual haul	No Federal facilities	n.a.
Marten Falls (Ogoki Post)	125	Wells and hand pumps & individual haul from river	Pressurized piped water from well	Money allocated for community water supply improvements
Moose Factory	921	Access to water supply lines	Pressurized piped water delivery	Piped water supply to the majority of homes
Muskrat Dam	138	Individual haul from river	Pressurized piped water from well	None
North Spirit Lake	225	Individual haul from lake	Pressurized piped water from lake	None
Osnaburgh	600	Individual haul from lake & well	Pressurized piped water from lake & well	Improvements in wells & water supply to Native homes
Pikangikum	817	Individual haul from lake	Pressurized piped water from lake	None
Poplar Hill	171	Individual haul from lake	Pressurized piped water from lake	None

Community	Population (1978) [1]	Present Water Supply [2]		Proposed Water Supply [2]
		Native	Non-Native	
Ponask	n.a.	Individual haul from lake	Pressurized piped water from lake	n.a.
Round Lake	435	Individual haul from lake & well	Pressurized piped water from lake	n.a.
Sachigo	222	Individual haul from lake	Pressurized piped water from lake & well	n.a.
Sandy Lake	1,151	Individual haul from lake & river	Pressurized piped water from river	Wells and improvements in community water supply
Slate Falls	n.a.	Individual haul	n.a.	n.a.
Summer Beaver	211	Individual haul from lake	Pressurized piped water from lake	Community water supply improvements
Webequie	390	Individual haul from lake	Pressurized piped water from lake	Community water distribution system
Winisk	235	Individual haul from river	Pressurized piped water from river	Extension of water line to community
Wunnummin Lake	273	Individual haul from lake	Pressurized piped water from well	Community wells (low-cost improvements)

[1] Northern Ontario Directory 1979/1980. Ministry of Northern Affairs. Ontario 1980.

[2] This information was provided by the District Managers of James Bay District, Sioux Lookout, Geralton and Kenora District. Gaps in information were clarified by Bill Grand, Director of Local Government, Regional Office, Department of Indian and Northern Affairs (personal communication, January 1980). Information on 'proposed' projects is based on projects planned within the next 5 years, as indicated in the 5 year capital management plans of each community.

n.a. information not easily available

TABLE 8 PRESENT AND PROPOSED SANITATION

Community	Present Sanitation[2]		Proposed Sanitation[2] (for Native community)
	Native	Non-Native	
Angling Lake	Outhouses	Septic system for school	None
Aroland	Outhouses	Septic system	n.a.
Attawapiskat	Outhouses & some septic tanks	Centalized collection & sewage treatment plant	Extend piped sewage collection to Native homes
Bearskin	Outhouses	Septic system for school	None
Big Trout Lake	Outhouses	Septic system & lagoon	Community sewage collection and treatment
Cat Lake	Outhouses	Septic system for school	Feasibility study planned for sanitation improvements
Deer Lake	Outhouses	Septic system for school	None
Fort Albany	Outhouses & some septic tanks	Septic system	Construction of sewers proposed
Fort Hope	Outhouses	Septic system and lagoon or weeping tile	Construction of sewers and treatment facility proposed
Fort Severn	Outhouses	Septic system	None
Grassy Narrows	Outhouses	Sanitary sewer and two cell lagoon	Construction of sewers proposed to majority of Native homes
Islington (White Dog)	Outhouses	Sanitary sewer and two cell lagoon	Construction of sewers proposed to Native homes & link to lagoon
Kasabonika	Outhouses	Septic system	None
Kashechewan	Outhouses	Septic tank & rotating biological contactor	None for community however regional subsidy planned for improvements in school sewage treatment

Community	Present Sanitation [2]		Proposed Sanitation [2] (for Native community)
	Native	Non-Native	
King Fisher Lake	Outhouses	Septic system for school	None
Lac Seul	Outhouses	Septic system	None
Lansdowne House	Outhouses	Sewers & rotating biological contactor	Community sewer system and treatment
Mac Dowell	Outhouses	No federal facilities	n.a.
Marten Falls (Ogoki Post)	Outhouses	Septic system & humus toilet	Feasibility study for sewage collection and treatment
Moose Factory	Outhouses & some septic tanks	Centralized collection & treatment	Proposed sewage collection and central treatment facility
Muskrat Dam	Outhouses	Septic system	None
North Spirit Lake	Outhouses	Septic system	Minor low-cost improvements in sanitation
Osnaburgh	Outhouses	Septic system	None
Pikangikum	Outhouses	Septic tank & lagoon	None for community however extremely costly sewage project for school
Poplar Hill	Outhouses	Septic system	None
Ponask	Outhouses	Outhouses at school	n.a.
Round Lake	Outhouses	Septic system	n.a.
Sachigo	Outhouses	Septic system	Community sanitation improvements
Sandy Lake	Outhouses	Septic tank & lagoon	Sanitation improvements
Summer Beaver	Outhouses	Outhouses	Sanitation improvements
Webequie	Outhouses	Septic system & chemical toilet	Sewers and central treatment facility proposed
Winisk	Outhouses	Septic system	None
Wunnummin	Outhouses	Septic system	None

[2] Same sources as in Table

TABLE 9 PRESENT AND PROPOSED SOLID WASTE DISPOSAL

Community	Present Garbage Disposal[1]	Proposed Garbage Disposal[2] (improvements)
Angling Lake	Individual disposal	None
Aroland	Individual disposal	None
Attawapiskat	Local dump	None
Bearskin	Community collection & local dump	None
Big Trout Lake	Local dump	Collection dependant on sufficient funding
Cat Lake	Individual disposal	None
Deer Lake	Individual disposal	None
Fort Albany	Community collection to local dump	None
Fort Hope	Community collection to local dump	New incinerator planned
Fort Severn	Individual disposal	None
Grassy Narrows	Band operated garbage collection to local dump based on user-fees	None
Islington (White Dog)	Band operated garbage collection to local dump based on user-fees	None
Kasabonika	Individual disposal	None
Kashechewan	Local dump	Access and improvements to local dump
King Fisher Lake	Individual disposal	None
Lac Seul	Individual disposal	None
Lansdowne House	Individual disposal	Community collection to dump
Marten Falls (Ogoki Post)	Community garbage disposal	None
Moose Factory	Community garbage collection to dump	Improvements in access and dump
Muskrat Dam	Individual disposal	None

Community	Present Garbage Disposal[1]	Proposed Garbage Disposal (improvements) [2]
Osnaburgh	Community collection to local dump	None
Pikangikum	Individual disposal	None
Poplar Hill	Individual disposal	None
Sachigo	n.a.	None
Sandy Lake	Individual disposal	None
Summer Beaver	Community garbage pit	None
Webequie	Community collection to local dump	None
Winisk	Local dump	None
Wunnummin	Individual disposal	Planned construction of a community garbage pit

[1] Same sources as in Table

[2] Proposed improvements in garbage collection and disposal based on fund allocation with in 5 year capital management plan of each community, as well as on information obtained from each district office

n.a. information not easily available

4. WATER SUPPLY

4.1 Appropriate Low-Cost Alternatives

4.1.1 Individual Haulage

In some communities, it might be decided that significant improvements should be made in excreta and wastewater disposal systems so as to keep the adjacent lake or river clean enough to drink from.

In such instances, desired improvements in water supply might be limited to access to communal shower/laundry facilities (see section 4.2.2 Community Bath-house and Laundry Facility).

Individual haulage of drinking water may be selected by the community as a reasonable alternative if the distance between the house and the lake/river is small, and if the water is clean near the shore.

Carrying water by hand (or using a cart) in the summer, and dragging it on a sled in the winter is the cheapest alternative, although also the most labour intensive and time consuming one.

To facilitate retrieval of water in the summer, a specially constructed cart may be used (see Figure 2).

Although some older people are seen doing things in a labour intensive way (ie dragging sleds by hand, sawing wood by hand etc), most families use power equipment such as skidoos and chainsaws.

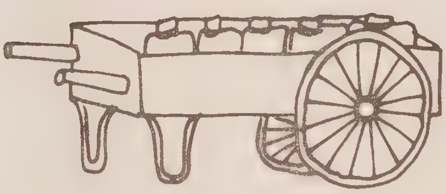


FIGURE 2 A two wheeled cart can be constructed to facilitate carrying of water in the summer. Bicycle wheels from bicycles no longer in use can be incorporated in the design of the cart.

4.1.2 Community Vendor

A community vendor could supply drinking water regularly to those families that wanted this service and were willing to pay for it.

Introduction of the community vendor would create employment for a few local people. It would also reduce the overall amount of gasoline used through individual haulage with skidoos. The vendor would have a specific daily delivery route. Total distance travelled by the vendor each day would be less than the total distance travelled by skidoo by all those hauling their own water.

The vendor would ensure that clean water is used. He might introduce use of a standard container (such as a 2 or 5 gallon plastic jerry can with a pour spout) to sell water in, picking up empties at each stop.

Pouring water directly from a clean container, rather than using an open vat and dipper, reduces the chance of contamination of the drinking water.

In winter, the vendor could use a skidoo and sled to deliver water.

In the summer, depending on the distances involved, the vendor could rent a community-owned truck for a few hours each day, or if not available, could construct a wheelbarrow-like cart.

4.1.3 Community Hand Pumps

Another alternative is to install several hand pumps located through out the settlement so that people must not go as far to haul water back to their homes. The cost of installation of a hand pump in each home would be prohibitive.

Before embarking on a community wide program of installing hand pumps, a test well must be dug and water acceptability determined. In Big Trout Lake, for example, 3 of 8 wells were judged to yield poor water quality. Water from these wells was not used for drinking or for cooking (Jackson et al, 1978).

Installation of hand pumps can be very costly in Northern Ontario because the bore for the drop pipe must often be drilled through bedrock. Special drilling eqipment must be flown in.

Although easy to use in the summer, hand pumps require more attention in the winter. Freezing of the pump in the winter results in the use of excessive force to operate it, and in subsequent damage.

To protect the pump and make it more pleasant to use in the winter, a small cabin should be built around it (see Figure 4).

Because frost can extend to 8 feet down (in non-permafrost areas) in Northern Ontario, it is important to insulate the first 10 feet or so of the drop pipe.

In the North West Territories, insulation for pipes usually consists of several inches of polyurethane insulation within an outer shaft.

Pumps are available which ensure that water drains down after each use to prevent freezing of the above ground components.

A thermal heating tape should be placed around the first 10 feet of the drop pipe. The heating tape is used only in the event of freeze up of the well head. A small portable gas generator would supply electricity to the heating tape as necessary.

A community may decide to forego the extra expense of upgrading a pump for winter use and decide to use hand pumps in the summer only. Collection of water is most problematic in the summer when water is carried by hand.

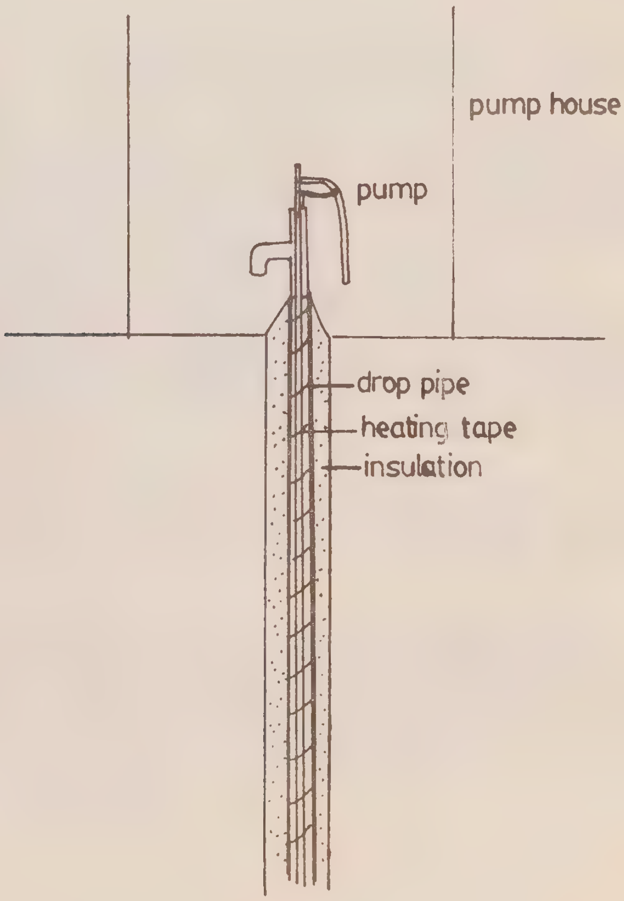


FIGURE 4

Community pump is housed in a small cabin. Insulation and thermal heating tape extend about 10 feet below ground level.

4.1.4 Community Infiltration Galleries

An infiltration gallery is a particularly suitable alternative for communities situated at the edge of a lake or river, as occurs at Indian settlements.

Water from the lake or stream moves laterally through a sand and gravel filled trench (see Figure 3). A well is dug down to connect to the trench.

A hand pump may be installed, or, if most of the community's water needs are to be met here, a fuel fired pump may be used. Cost and materials considerations will determine whether one central gallery be constructed, or several small ones dispersed along the water's edge.

The advantage of using an infiltration gallery is that water is filtered and purified while moving laterally through the sand and gravel trench. The length of the filtration channel depends on the purity of the water desired. Addition of chlorine is unnecessary.

This alternative is suitable only where sand and/or gravel deposits occur nearby.

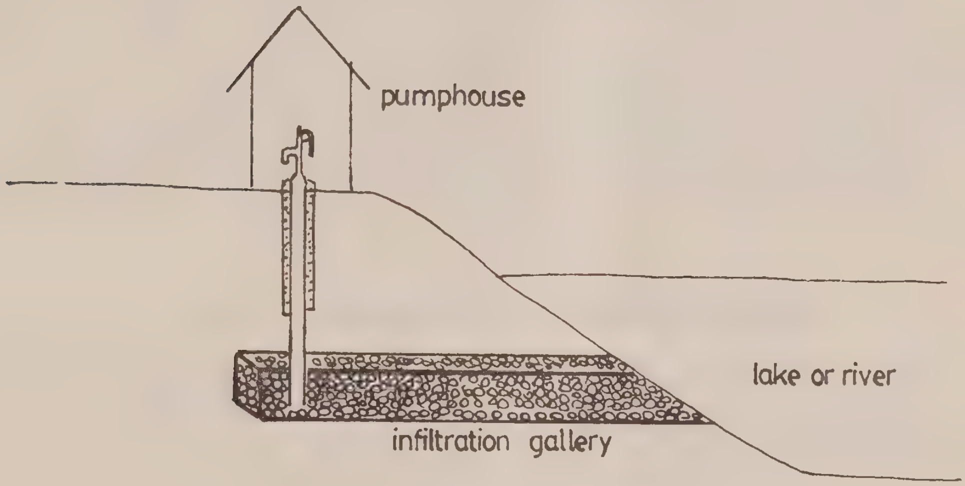


FIGURE 3 Water is purified as it moves laterally through the sand and gravel of the infiltration gallery.

4.2 Appropriate High-Cost Alternatives

4.2.1 Vehicle Delivery of Water

Use of a vehicle (truck or tracked vehicle) to supply water to each home greatly reduces human labour requirements in the daily lives of Indian people.

Both operating and capital costs are high. Before water is trucked in, it might be decided that the water should be filtered and chlorinated.

If a central bath-house and laundry facility were constructed in each community, at-home water needs could be sustained at 7 L/person/day (1.5 gal/p/d) (see Section 3.2 Water Use).

In a community with no roads, a tracked vehicle is required. Tracked vehicles are more expensive to purchase and maintain than trucks (Water Pollution Control Directorate, 1979).

In the North West Territories, the standard water holding tanks for vehicles have a capacity of 1000 gal (4,450 L). The tank must be insulated and have a heater system to prevent freeze up in the winter.

Water delivery could occur once a week. A family of 6 with access to a central bath/laundry facility and low at-home use of water would require 300 to 400 L/week. A standard 4450 L water delivery truck could supply 11 to 15 families with their weekly water requirement on one run.

In smaller communities, a smaller capacity water supply vehicle may be more economical, even if it has to make more frequent trips. It is important to match the scale of the technology with the scale of the task.

The delivery vehicle should be equipped with a long hose (50 to 100 feet). Even where roads exist, Indian homes may be set back quite far from them.

Water Storage in the Home

The amount of water that is to be supplied to the home depends on whether a communal laundry/bath-house is constructed, or whether all water use will occur at home. It is assumed that a waterless method of excreta disposal will be used.

Recommended water usage for those hauling their own water is 10 L/person per day (2 gal/p/d) (Water Pollution Control Directorate, 1979) (see Table 11).

For those families with no access to a central facility and with a waterless toilet, recommended water usage is 15 L/person/day (3.5 gal/p/d) (Water Pollution Control Directorate, 1979). This represents a 50% increase in water use at present.

As established earlier in this report (see Section 3.2 Water Use) non-laundry water usage is less than 7 L/person/day. Increasing water supply to 10L/person/day for non-laundry uses would enable more frequent washing of hands after going to the toilet, changing baby diapers, before preparing food etc.

TABLE 10 ACTUAL WATER USAGE

	Amount (litres)
Total water used	8 to 10
Non-laundry uses	7

TABLE 11 RECOMMENDED WATER USAGE

	Amount (litres)
Individual haul	10[1]
Truck in total water	15[1]
Truck in/access to central facility	10

[1] Water Pollution Control Directorate, 1979.

Vehicle deliveredwater should be stored in clean receptacles inside the house. Water storage capacity required by each household (assuming once a week delivery) is indicated in Table 12 .

TABLE 12 WEEKLY WATER STORAGE CAPACITY REQUIRED

No. in household	Capacity required in litres (gal)	
	10 L/p/d	15 L/p/d
2	140 (30)	210 (45)
4	280 (60)	420 (90)
6	420 (90)	630 (140)

A storage tank that is placed inside the house will eliminate the need to insulate and heat the storage tank.

Storage tanks can be constructed locally of wood, eliminating the need to fly in heavy tanks. Wooden tanks should be lined with a prefabricated polyethylene (plastic) liner. The wooden tanks can be built as part of the kitchen design (see Figure 5).

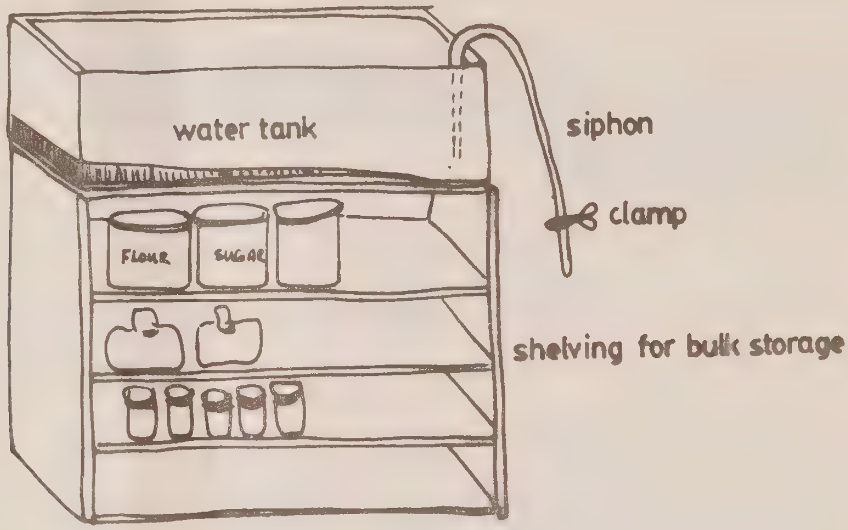


FIGURE 5 Water storage tank placed above sink level to get gravity flow of water supply. Space below tank filled in with shelves for bulk storage of food.

Placing the bottom of the tanks above sink level would permit supply of water to the sink through gravity flow.

A water supply line can be made from a piece of tubing with a filter at one end and a clamp at the other. Two diameters of tubing can be used, one for fast flow and one for slow flow.

The tanks should have lids on them to keep the water clean. Enough space should exist between the top of the tank and the ceiling to permit cleaning of the unit as necessary.

An access portal for the hose of the delivery vehicle can be constructed in the wall of the house at a level above the tank.

Cleaned, water-proofed 45 gallon drums may be used to store water in a similar arrangement as for the wooden tank.

Although more expensive, it might be preferred to have a premanufactured steel or fibreglass tank installed.

4.2.2 Central Facility

Community Bath-house and Laundary Facility

Conventional piped water supply and piped wastewater collection to each native house in northern Ontario becomes an exorbitantly expensive venture because of severe environmental conditions (shallow rocky soil, muskeg, frost extending up to 8 feet down) as well as the dispersed nature of housing.

Trucking in large quantities of water and trucking out large quantities of wastewater, although a cheaper alternative, is still very costly.

A community laundry and shower facility is worthy of serious consideration. Instead of transporting to the house the total amount of water used in everyday living, the central facility operates on the principle that only as much water as is required for drinking, cooking, washing dishes, daily washing and household cleaning is supplied to each home, and that the central facility fulfils water supply needs for doing laundry and taking showers.

Present water use in Big Trout Lake (water is hauled individually by each family) is indicated in Table 5 (see section 3.2). Average total consumption is 1.8 gallons per person per day (~9 L/person/day). Of this, 70 % is used for drinking, cooking, washing dishes, daily washing and house cleaning. Clothes are washed weekly and uses about 30 % of the total water supply.

Trucked water supply and wastewater collection is presently being advocated for Big Trout Lake. The annual cost for supplying water (at 15 L/person/day) is estimated at $50,000. Annual wastewater collection costs are also about $50,000 (Cameron, 1979 : Appendix H of User's Making Choices, Jackson et al, 1978).

Although Cameron (1979) indicates that unit water supply and wastewater collection costs become cheaper the greater the volume used, it must be remembered that higher use rates require larger more expensive holding tanks at each home.

Such economies of scale can easily be misinterpreted by the consumer who feels he is getting a bargain by using more water. Although the unit price might be cheaper, the total bill will be more.

In the case of Big Trout Lake, $100,000 are required annually for water supply (15 L/p/d) and wastewater collection. If only 6.5 L/p/d (present use rate for non-laundry water uses is 6.3 L/p/d) were trucked in and out, this would free about $50,000 annually for the central bath-house and laundry facility.

Although a costing study is required, it is anticipated that a combination of low volume water delivery plus central facility is less expensive than higher volume water delivery to each household with laundry and bathing occurring at home.

The cost comparison between the central facility and at home washing of clothes and bathing should include the costs incurred in each household for gasoline or electrically run washing machines (capital and operating costs), as well as water heating costs etc)

It can not be overemphasized that the decision as to the type and level of service planned be the decision of the entire community, as established through the band office.

It is the personal opinion of this author, however, that access to a central facility would be viewed as a substantial improvement over at home bathing and washing of clothes.

Trucking in cold water to a home is of no great benefit to the process of bathing and laundering if adequate facilities do not exist in the home.

Clothes are washed once a week. Generally, water is heated in a pail on a wood stove (made of a 45 gallon drum). Some washing machines exist, however in many communities laundry is done by hand. Clothes are hung to dry outside in winter and summer. In winter, clothes are frozen stiff even before they reach the clothes line. After 2 or 3 days of flapping in the wind, clothes are taken inside and hung on lines to dry for another day.

Native homes have no internal plumbing, showers or bath tubs. Even if sufficient water is supplied, bathing would be difficult unless a substantial amount of money is invested for a tub, water heater, etc.

Indian life tends to be communal, unlike the more individualistic lifestyle of white communities. A communal bath-house and laundry facility does not appear incongruous to native lifestyle.

Data from Alaska indicates that the amount of water consumed (and wastewater generated) in native communities with trucked water, no internal plumbing, waterless toilets and access to a central bath-house and laundry is 3.3 gal/p/d (15 L/p/d)(Water Pollution Control Directorate, 1979). This indicates that access to running water at the central facility did not promote extravagant water consumption.

Water and Energy Conservation at the Central Facility

In non-native communities, introduction of 'user-fees' (the consumer pays directly for what he uses) usually functions to instill conserver habits in the user.

Whether the concept of 'user-fees' is applicable in native communities must be decided by the Band Council and the community itself.

Charging for each shower might be viewed as discriminatory against those with large families.

The facility might contain washers, dryers, showers, a sink and a waterless toilet.

Washers

Commercial washers should be used because they are large enough to handle bulky items such as sleeping bags, blankets and parkas (Water Pollution Control Directorate, 1979).

Front loading horizontal axis washing machines are preferable in that they use 40% less water than top loading vertical axis machines (Cameron, 1979). However, because horizontal axis machines tend to vibrate more, they require a solid base such as concrete or heavy timbers in their installation (Cameron, 1979).

Dryers

Electrically operated dryers are the most expensive to operate, but the easiest to maintain (Water Pollution Control Directorate, 1979).

Electrical clothes dryers consume about 10 times as much electricity as electrical clothes washers (from a Consumer's Gas brochure). Because of the high energy demand of dryers, it merits serious consideration to investigate alternative sources of dryer heat.

A hot air furnace with appropriate duct work can provide dryer heat. Such a system is not damaged by freezing, but ducting must be well insulated to reduce heat losses (Water Pollution Control Directorate, 1979). Thermostatically controlled wood furnaces could supply heat.

Whether a community wishes to have dryers or not must be established. Some people may prefer to dry their clothes in the fresh air. Perhaps the community as a whole feels that the extra expense of dryers does not match the benefit.

Showers

A standard shower head delivers between 5 and 6 gallons of water per minute (about 25 L/min). Use of a flow restrictor and/or a special shower head can halve flow rate and still provide a satisfactory shower.

Shut-off controls on shower heads encourage additional water saving. The selected water temperature is maintained during shut-off while shampooing or lathering, provided a small trickle of water is allowed to persist.

Toilet

The toilet should be the same type as used in native homes. It is important to be consistent in the mode of excreta collection within a community to prevent ranking of which is more desirable.

A waterless toilet is recommended for the central facility (see section 5.1 Excreta Disposal: Appropriate Low-Cost Alternatives). Urine can be added to the laundry and shower greywater for separate disposal.

4.3 Inappropriate Alternatives

4.3.1 Piped Water Delivery

To prevent damage from freezing, piped systems need to be buried 8 feet below ground surface and insulated, or placed in insulated corridors (utilidors) above or below ground.

Costs are extremely high for such a system, particularly given dispersed housing situations.

Table 13 shows that unit cost per home for water delivery is about $5,600. This is a minimum cost, which because of certain conditions will require a cost increment.

These costs are only the costs of getting water to each house. Additional costs will be costs of internal plumbing, appliances, wastewater collection and disposal.

TABLE 13 ESTIMATED PIPED WATER DELIVERY COSTS PER HOME

	Cost per home
Community water supply system from lake or river (100 homes)	$1,000
Water treatment plant (100 homes)	2,100
Water distribution (100 homes) (assumes 23 m of main/home and 18 m of service connections/home)	2,500
Total	$5,600

Source: Department Reference Manual. Indian and Northern Affairs. 1979.

5. EXCRETA DISPOSAL

We are just beginning to realize the folly of inventing a complex and expensive technology to mix our body wastes with our purified drinking water, and then inventing an even more complex and expensive technology to separate these body wastes from our drinking water.

The development of the flush toilet took society down the wrong path a century ago. Now that we have the multi-million dollar subterranean maze of pipes installed beneath our communities, it becomes difficult to ignore them.

However, for those communities not yet underlain by sewers, development of alternative sewage collection and treatment methods makes sense.

Conventional sewage disposal systems that rely on water to transport body wastes are troublesome for numerous reasons.

Expenditures (capital, operating, maintenance costs, debt financing etc) for sewer lines and treatment plants are enormous.

In northern climates, these costs are escalated to the point where the user can no longer afford to pay for the system himself but must rely on heavy subsidies from the government.

In a climate where air temperatures are below freezing for at least six months of the year, use of water to transport body wastes seems unreasonable.

Where the climate is harsh, it seems even more pressing to minimize the volume of waste generated to make for easier transport and treatment.

The modern flush toilet not only wastes large quantities of purified drinking water to carry away small quantities of body wastes, but also magnifies the disposal problem by enlarging the quantity of wastewater to be disposed of.

Use of water to receive our body wastes misplaces plant nutrients into our lakes and rivers, instead of returning body wastes to the land from which they are derived.

Further research may indicate that bodies of water in northern climates do not have as great a capacity to receive body wastes as in southern climates.

Eutrophication and biological contamination are particularly significant in northern communities where the waters receiving body wastes are also the waters providing drinking water.

5.1 Appropriate Low-Cost Alternatives

5.1.1 The Drum Privy

A drum privy is used to collect excreta directly, without the introduction of water as the transport medium. Body wastes are deposited on-site into the drum. Once the drum is full, it is sealed and transported to a central area where the contents of the drums of the entire community can be treated.

By depositing wastes directly into the container to be collected and sealing the container when full, human contact with excreta is avoided.

Separate Collection of Urine and Feces

Urine is delt with separately from feces. There are several reasons for this.

The excreta inside the drum will eventually be composted as part of their treatment process (see section 5.1.2 Community Composting). Both anaerobic and aerobic decomposition are most successful in the absence of the excess liquid provided by urine.

Each day, each of us eliminates about 1/2 pound of feces and 1 quart of urine (Gotas, 1956). In terms of volume, we generate about 5 times the volume of urine as of feces.

In warm climates, much of the urine evaporates during decomposition, however, amounts evaporated decrease substantially in cold climates. It is especially important in northern environments that urine be separated from the feces if composting of excreta is planned.

Living organisms require available carbon as a source of energy and need nitrogen to synthesize protoplasm. The optimum ratio of carbon to nitrogen required by microbes in decomposing most types of organic wastes is about 25 or 30 parts carbon to 1 part nitrogen (Golueke, 1977).

When nitrogen occurs in excess of this ratio, this excess can not be synthesized into new cellular material because carbon is lacking. Excess nitrogen is converted to ammonia gas. Hence the foul smell.

Urine by dry weight contains 3 to 4 times the amount of nitrogen as feces (Stoner, 1977). The C/N ratio of feces ranges from 6 to 10. For urine, the C/N ratio is about 0.8 to 1 (Golueke, 1977). It can be seen that by mixing urine and feces, a greater excess of nitrogen is introduced. Hence, the more ammonia that is produced, the more foul the air.

By collecting only feces in the drum, production of foul odours will be less than if collecting both urine and feces.

Another reason for collecting only solids in the drum is that the urine, as it evaporates and becomes more concentrated, might increase corrosion and rusting of the barrels.

A damaged drum that leaks a solution of urine transports pathogens with it from the feces. This would create a health hazard.

The 45 Gallon Drum

The 45 gallon drum is a common item on all northern Indian communities because it is used to deliver fuel (usually via airplane). In southern Ontario, a drum is a valuable container for which the buyer pays a $15 to $25 deposit. The buyer is refunded his deposit upon returning the drum.

In northern Ontario where fuels and supplies are flown in by aircraft, it is uneconomical to fly out empty barrels for re-use. Hence, empty 45 gallon drums are abundant in most communities.

Generally drums are used as wood stoves to heat homes. Drums are not of sturdy enough construction to withstand the continuous raging fire needed to heat the home. Drums tend to be replaced about three times a year.

Introduction of the more efficient airtight wood stove or wood furnace (see Associated Appropriate Technologies, section 8.1) would free up these drums for other uses, such as collection of human excreta and garbage.

Prepare drum for use by coating interior with an asphalt emulsion or polyurethane spray (Office of Appropriate Technology, 1977).

Number of Drums Needed

On the basis that each person produces 0.5 pounds of feces per day, one 45 gallon drum will require 900 days of use by one person to completely fill it. However, to avoid possible contact with the contents during capping, fill barrel no more than 80% of capacity (about 720 days use by one person).

A drum filled 10" from the top will weigh about 360 pounds.

In the calculation for determining the number of drums required per person per year (see Table 14), it was assumed that no evaporation of water from the feces would occur. Thus, these numbers represent the maximum number of barrels required. In reality, it is anticipated that water will evaporate through the exhaust pipe, resulting in more uses per barrel than calculated.

Table 14 Rate of Use of Drums per Household

No. in Household (People)	No. Drums Filled Per Year (Drums)	Time Required To Fill One Drum (Months)
1	0.5	24
2	1.0	12
3	1.5	8
4	2.0	6
5	2.5	4.8
6	3.0	4
8	4.0	3
10	5.0	2.4

Drum Privy Design

The drum privy may be constructed as a free standing structure several feet from the house. No advantage is obvious in such an alternative, however, it may be the solution preferred by those extremely concerned by the unlikely event of odours in the house if attached.

The most superior alternative is to design a toilet room (and greywater storage as required) as part of a new house.

For existing houses, a toilet room may be constructed adjacent to the house.

Most houses on Indian communities lack a vestibule at the entrance. Presence of a vestibule acts as an air trap, hindering the massive outflux of heated air from inside the house and the massive entry of cold air from outside when entering or leaving the building.

Figure 6 shows how an existing house may be modified to include a vestibule, toiletroom and greywater storage area (if required).

For large households, it may be desirable to provide space for the storage of a drum, since drums fill up more quickly and might not be able to be removed immediately. Or, if the 360 pound weight of the filled drum is unmanageable, it might be preferred to fill the drums 1/2 full and replace them more frequently with empty ones.

Two designs are presented. The first design (see Figure 7) is suitable for situations where the floor of the house is atleast 3 feet above the ground.

The toilet room is constructed so that the drums sit at ground level. The floor of the toilet room is elevated so that the drums (4 feet tall) fit in the space under the floor. For a house with a floor three feet above ground level, the floor of the toilet addition will be 1 foot higher than the rest of the building.

Removal and replacement of drums is done from an access door outside.

To extend the distance between the individual and his excrement, a wooden shaft (about 1 1/2 feet long) is built up from the drum (Office of Appropriate Technology, 1977) (see Figure 9). A bench across the width of the toilet room encorporates the feces chute and urinal into a pleasing unit (see Figure 10).

To facilitate positioning and removal of the drum, place on a wooden cart with strong wooden or steel wheels (see Figure 9).

Ensure that odours remain within drum when not immediately in use by using a sealing strip (rubber or foam) at the drum/ floor intersection. An airtight seal on the toilet seat should prevent odours from escaping into the room. Keep lid shut at all times when not in use (Office of Appropriate Technology, 1977).

Because any decomposition that does occur within the drum will be primarily anaerobic, ammonia, hydrogen sulphide or methane gas might be given off. It is anticipated that the amounts of gas given off during winter will be small because biological activity is greatly reduced at low temperatures. Venting functions primarily to allow gases produced in the drum to escape (gradually rather than explode). Because the process is designed to be anaerobic, no provision is made to supply oxygen to the drum. The exhaust vent can be constructed from narrow diameter (1 or 2 inch) PVC piping.

The exhaust pipe should have a snow and rain cap. Screening of the cap is important to prevent breeding of flies within the drum, which might cause fecal contamination on contact with people.

The toilet room, although not heated, offers protection from wind, rain and snow. It is more attractive to use than an outdoor privy in that there is no need to get fully dressed (boots and coat) to use it.

The toilet room is accessible via the vestibule. Air exchange between the toilet room and the main portion of the house is negligible.

By keeping the toilet room unheated, it is anticipated that decomposition, and hence odours will be especially minimal during winter.

A functional window allows light and fresh air to enter as desired.

Used diapers should not be thrown down the chute because the plastic lining will not decompose. Instead, collect diapers in a plastic bag and store out of sight in the diaper storage compartment (see Figure 10) until collected for incineration.

The second privy design is such that the drums sit on a cart on the floor of the toilet room itself (see Figure 11).

Removal and replacement of tanks occurs through access doors inside the toilet room (see Figure 13).

Access doors and a bench hide the drums and urinal from view (see Figure 13). Because the top of the bench is about 4 feet above the floor, stairs are required to provide easy access to the toilet chute and urinal. The top stair can be extended into an upper platform. The stairs can be moved when it is necessary to change drums.

The height of the ceiling in the toilet room will depend upon the amount of space required above the bench.

Drum Privy Use

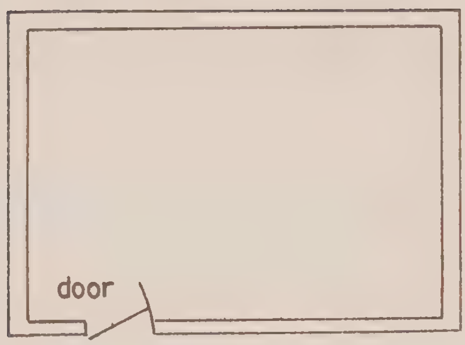
The containment of excreta (feces only) in a tank under anaerobic conditions is presently in wide spread use in Viet Nam (Ministry of Health, Viet Nam, 1968). This system is repudiated to be free of foul odours.

After each use, a layer of ashes is sprinkled on the pile in the ratio of 1 part ashes to 3 parts waste. A small handful should be used at each 1/2 pound deposit of feces.

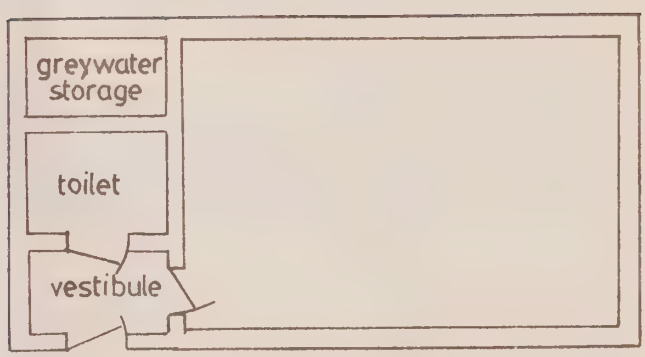
Sprinkling ashes on the feces is reported to prevent multiplication of flies, as well as absorb the odours of hydrogen sulphide and ammonia (Ministry of Health, Viet Nam, 1968).

Use of a moderate amount of toilet paper is permitted. Paper is abundant in carbon, and in small quantities helps raise the carbon/nitrogen ratio in the excreta pile. Large clumps of toilet paper should be stored and eliminated with the used diapers.

When not in immediate use, the lid to the toilet chute should be down. Aerate the toilet room by opening the window as frequently as desired.



Floor plan - Original house with no vestibule



Floor plan - House with vestibule and toilet addition

Figure 6 Additions to existing house

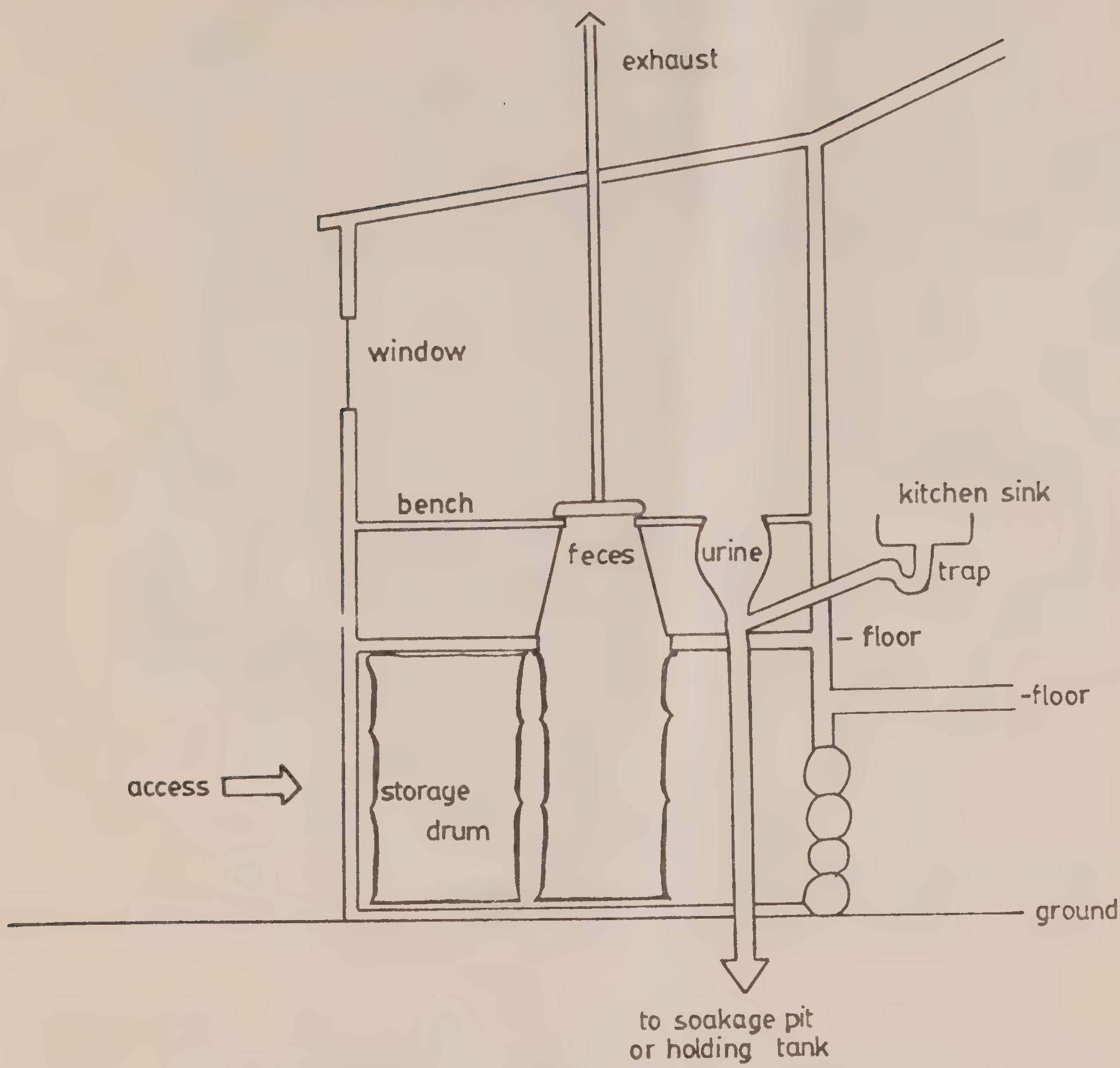


Figure 7 Front section of toilet area added onto existing house. Only solid excreta are collected in drum. Greywater from kitchen area flushes urine drain by gravity flow.

Drum is submerged below floor of toilet room. Bottom of drum is at ground level. Drums are removed from the outside through an access door at ground level.

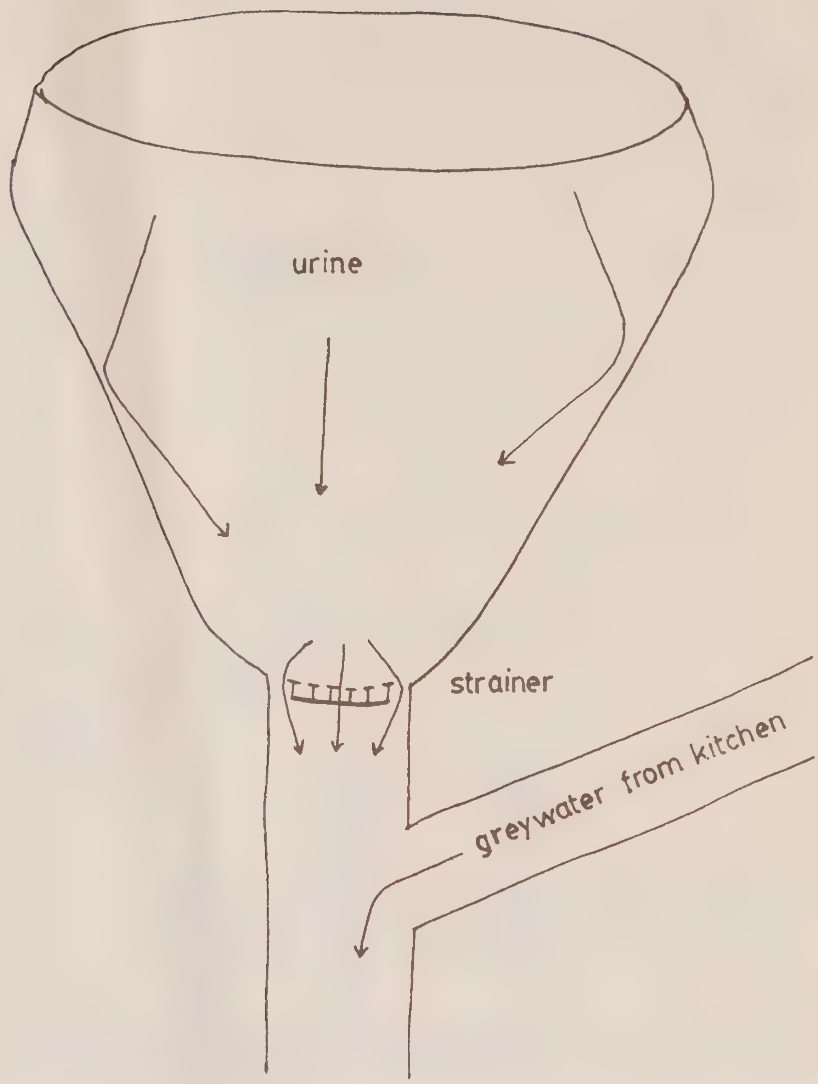


Figure 8 Ensure flushing of the urinal drain pipe by making greywater connection as close to top of pipe as possible and still have gravity flow. Urinal requires strainer to keep unwanted objects from accidently falling down the shaft.

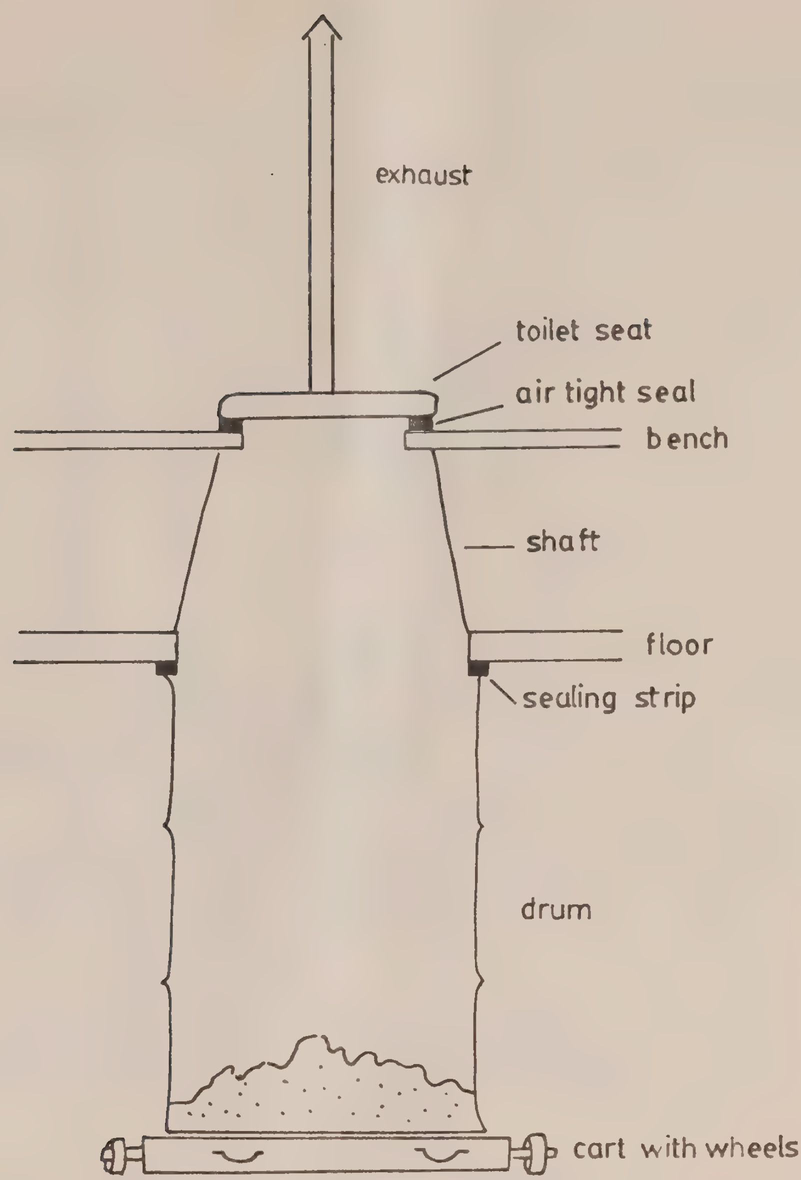


Figure 9 Side view of drum privy on cart for easy placement and removal. Air-tight seal ensures that stale air from the drum does not leak into the toilet room when not in use.

(adapted from: Rural Wastewater Disposal Alternatives. Office of Appropriated Technology. California. 1977)

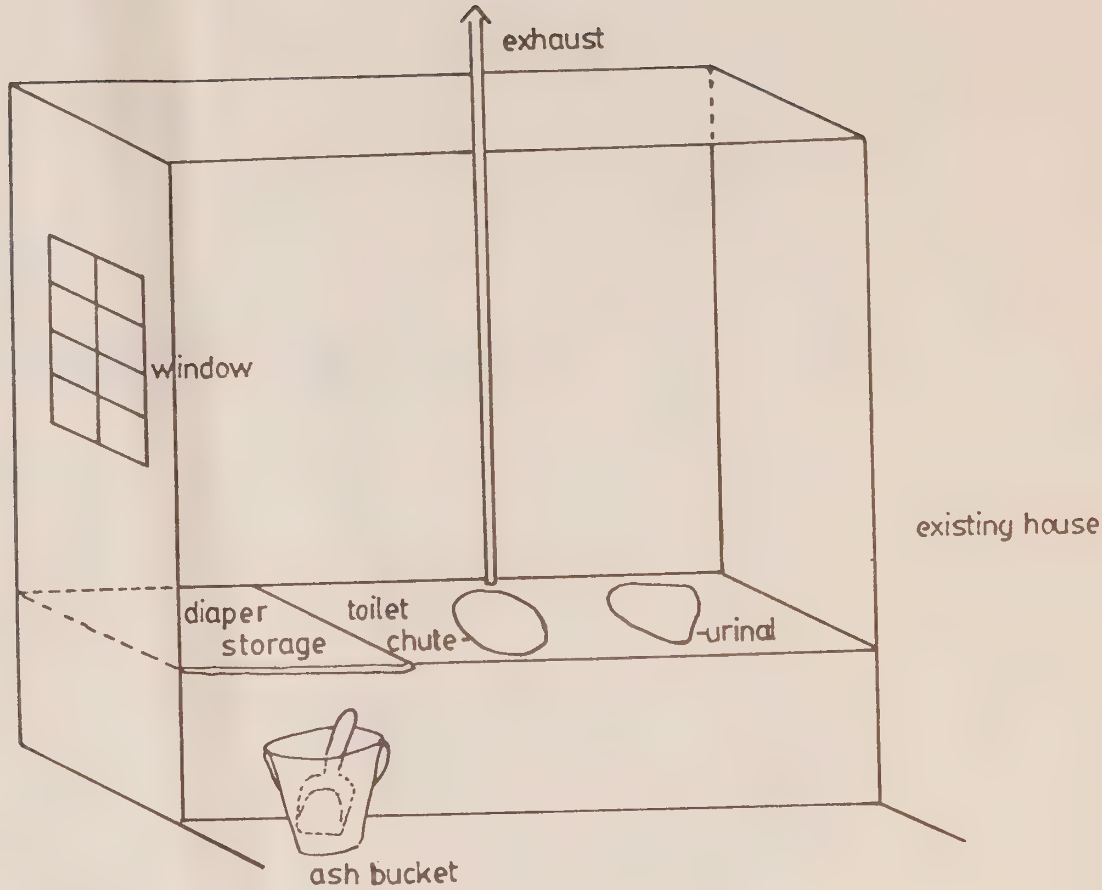


Figure 10 Interior of toilet room. Urinal has no lid. The adjacent hole is for feces only and has an airtight lid. Storage bin beside the toilet chute may be used to store used diapers. Bucket of ashes permits easy application to feces chute after each use. Window allows fresh air and light to enter. The bench is about 1 1/2 feet above the floor.

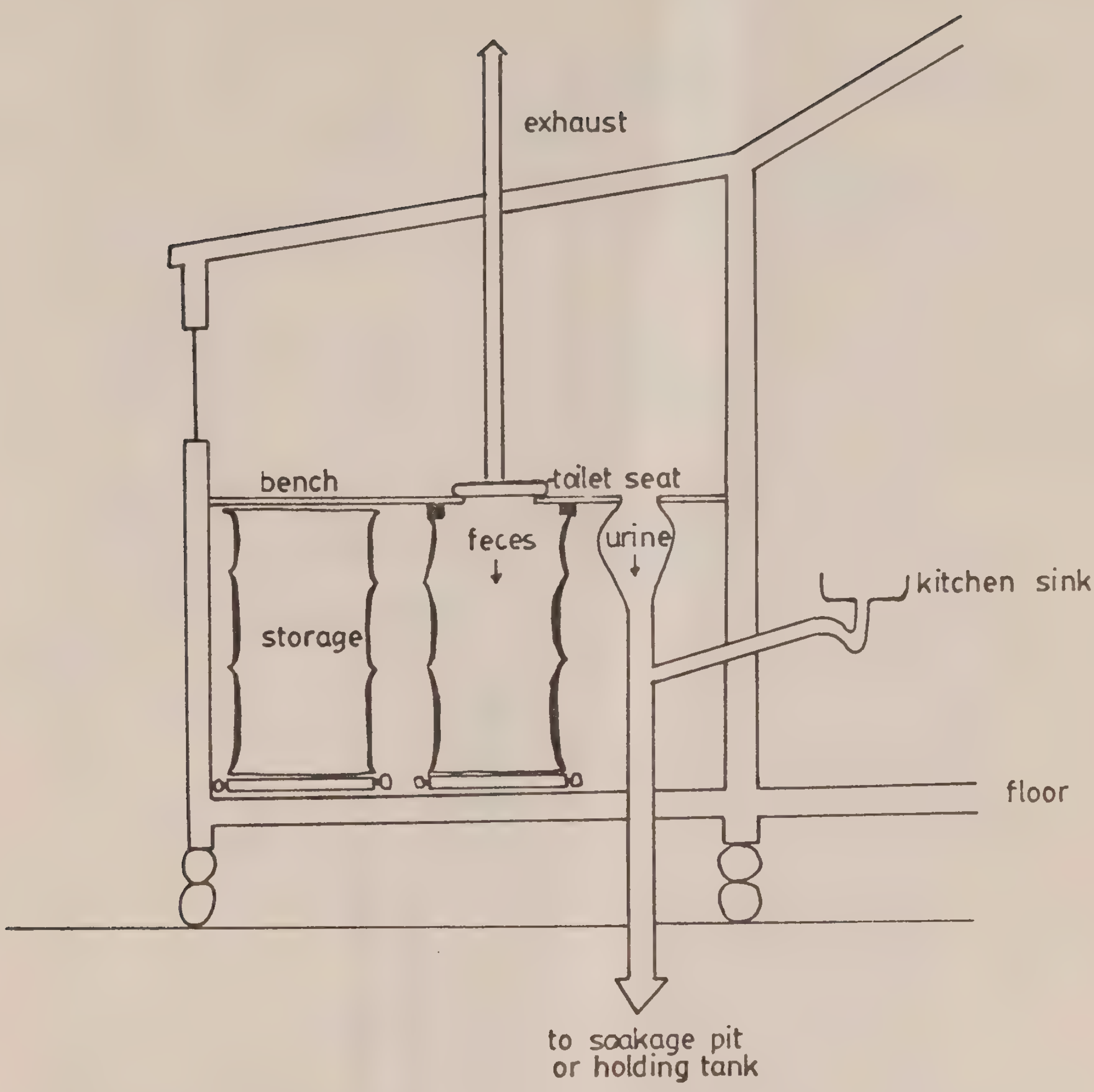


Figure 11 Front section of toilet area added onto existing house. Drums sit in wooden compartment. Top of the compartment functions as a bench.

Both drums are on wooden carts for easy removal. The drums sit on top of the floor of the toilet room and must be removed from inside the room.

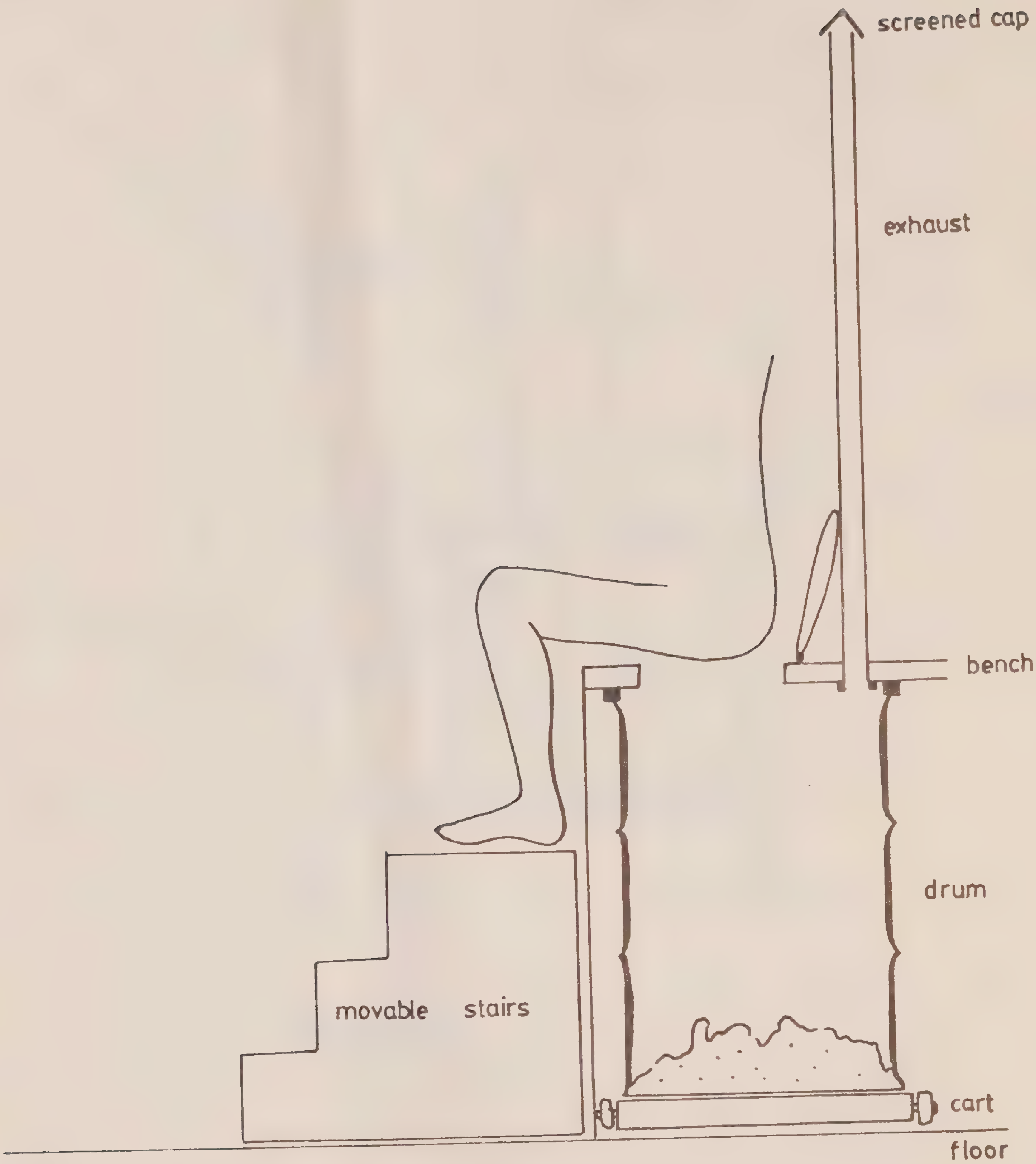


Figure 12 Side elevation of drum privy placed at normal floor level in the toilet room. Movable wooden stairs can be moved to achieve access to the compartment containing the drum. Drum rolls out easily on wooden or steel wheeled cart.

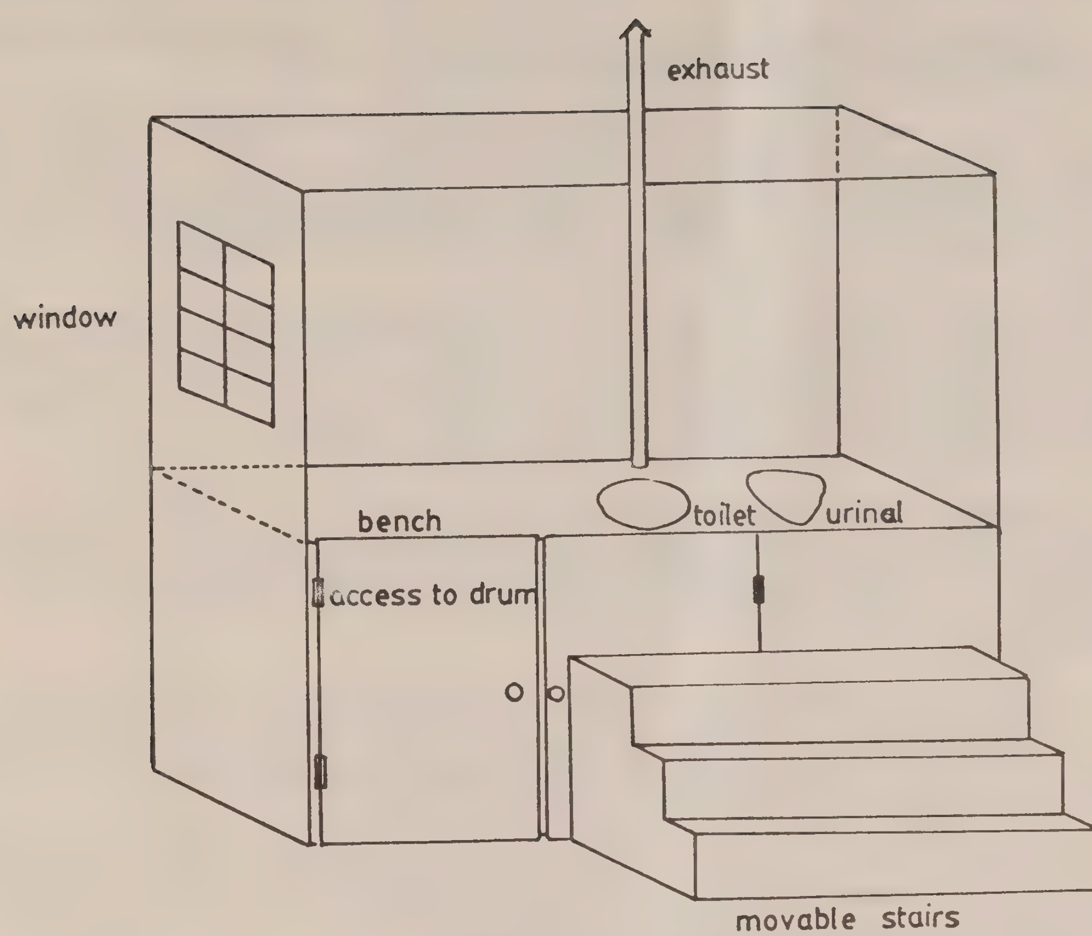


Figure 13 Interior view of toilet room. Both privy drums sit on top of the floor and must be removed from inside this room. The toilet seat is about 1 1/2 feet above the upper stair.

5.1.2 Communal Composting

Anaerobic Versus Aerobic Composting

In North America, aerobic composting is usually preferred to anaerobic composting. Although more difficult to achieve, aerobic composting is repudiated to proceed relatively odourlessly.

Anaerobic composting has been much maligned in North America. Experimentation at the small-scale level is rare.

However, anaerobic composting seems to be much more suited to life at northern Indian communities than aerobic composting. Because it proceeds in the absence of oxygen, decomposition can occur right within the drum. There is no need to remove the excreta from the drum, or mechanically stir or aerate it.

By allowing the excreta to remain in the drum during decomposition, human contact with the raw feces is avoided and dangers of contamination are minimized. Futhermore, by eliminating the need to turn over the pile to aerate it, physical labour and machine and fuel requirements are greatly reduced.

Although anaerobic digestion (a process which produces methane gas and proceeds with the addition of heat in a special digester) is a widely practiced method of dealing with excreta and sludge, little information exists on simple anaerobic composting.

Anaerobic composting occurs at lower temperatures than aerobic composting, and is thought to occur more slowly (Stoner, 1977). In Viet Nam, however, experience with anaerobic composting has been extremely favourable.

Anaerobic composting retains more nitrogen in the composted material than aerobic composting. In the aerobic process, loss of nitrogen through evaporation is twice that for the anaerobic process (Ministry of Health, 1968).

As the anaerobic breakdown of organic nitrogens in the feces proceeds (protein in feces → peptides → amino acids → inorganic ammonium compounds) the per centage of inorganic nitrogen (such as ammonium nitrate) increases. Ammonium nitrate is valuable as a plant nutrient in that it occurs in a form readily taken up by plants.

Anaerobic composting with ashes provides other valuable plant nutrients such as potassium and phosphorus. Fresh feces contains 1.3 grams potassium and 1.1 grams phosporus per 100 grams fresh feces. Upon composting anaerobically with ashes, this compost contains 4.2 grams potassium (200% increase) and 1.3 grams phosphorus (15% increase) (Ministry of Health, Viet Nam 1968).

The Viet Namese Double Septic Vault

The Viet Namese double septic vault is a latrine for on the spot composting of excreta. One vault is used for defecation; the other for composting (see Figure 14).

The hole is covered with a lid to keep off flies. A groove in the squatting plate channels urine away from the tank. The compost is ready for field application after two months of composting in situ.

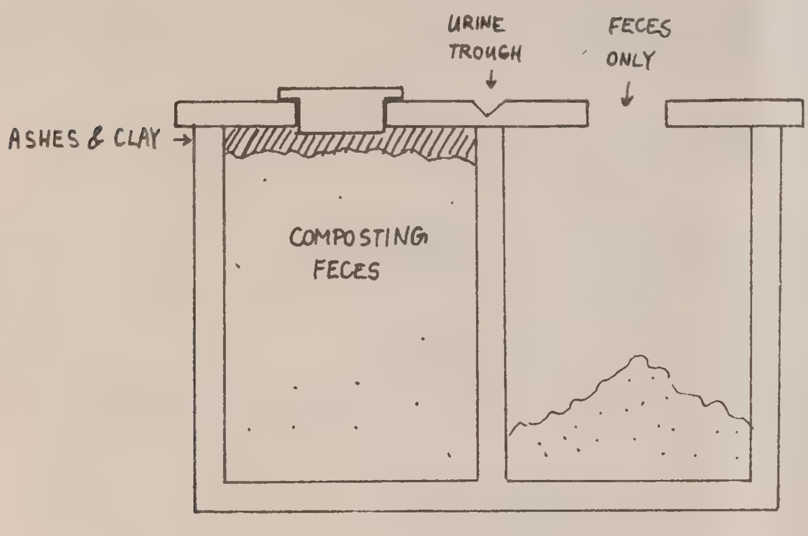


Figure 14 Viet Namese Composting Privy

(After: Goodbye to the Flush Toilet. C.H.Stoner, 1977)

To make this system applicable to Indian communities in northern Ontario, the Viet Namese vault (made from bricks and concrete) is replaced with a 45 gallon drum. Drums are readily availabe in Northern Ontario, whereas bricks and concrete would be costly to fly in.

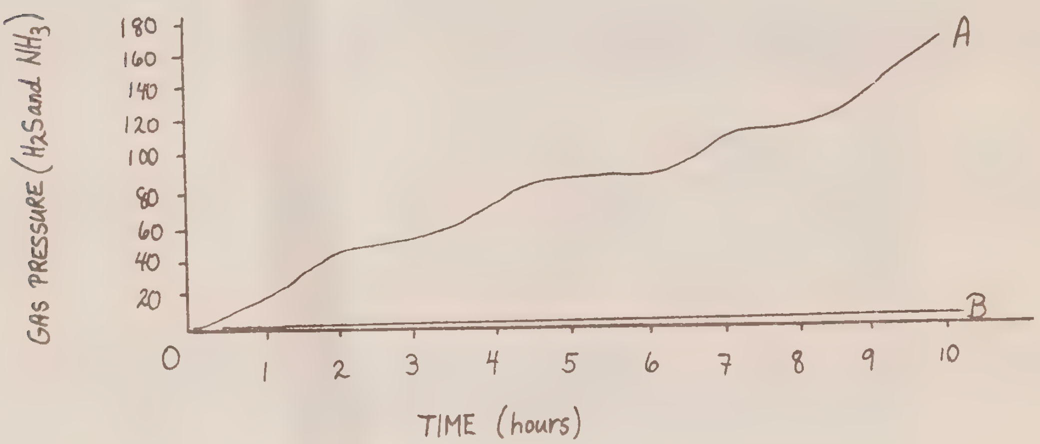
Another major modification is that excreta are not treated on-site, but are hauled to a centralized treatment area. For the Viet Namese, farming is part of their culture. Composted organic matter is vital to and used by each family.

Farming is not part of the culture of Northern Ontario's Indian communities. Unfavourable soil conditions and severe climate make farming impossible. Although large scale farming is unfeasible, a small community garden is possible. Because of the scarcity of suitable land, and because of the communal nature of Indian settlements, it makes sense to collect the feces, compost it centrally and use it as a community resource.

Anaerobic Composting

Experiments carried out by the National Institute of Hygiene and Epidemiology show that ashes effectively neutralize bad odour (Ministry of Health, Viet Nam 1968). Figure 15 shows no exhalation of hydrogen sulphide and ammonia gas in the 10 hour period after mixing 1 part ashes (by weight) with 3 parts fresh feces (by weight).

Figure 15 Comparison of Odour Emission with and without Addition of Ashes



Line A: shows exhalation of bad-smelling gas from fresh human waste after 10 hour's experimentation

Line B: shows no exhalation of gas from fresh feces mixed with ashes (ratio 30 gm feces to 8 gm ashes)

Source: Viet Namese Double Septic Tanks, Ministry of Health, Viet Nam 1968.

During anaerobic composting within the septic vault in Viet Nam, it is observed that the temperature inside the tank is 2°C to 6°C higher than outside air temperature. In summer it may reach nearly 50°C in the tank when it is 28°C to 32°C outside.

Material composted for 8 weeks becomes dark brown and dry. Laboratory tests do not reveal the presence of bacteria causing typhoid fever (Salmonella, Salmonella typhi, para A, B) or of bacteria causing dysentry (Shigella, Shiga, Flexner, Sonnei). After 6 to 7 weeks of composting, virtually all E. Coli bacteria are killed.

Thermal death points of some common pathogens and parasites appear in Table 15 . This chart indicates the temperature and time of exposure required for destruction of these organisms, however, it must be remembered that temperatures within the pile are not uniform. Time until death is very short in this laboratory set up. In reality, composting occurs for a much longer time period, adding additional stress on these organisms.

Table 15 THERMAL DEATH POINTS OF SOME COMMON PATHOGENS AND PARASITES

Organism
Salmonella typhosa: No growth beyond 46°C; death within 30 min. at 55° to 60°C.
Salmonella spp.: Death within one hour at 56°C; death within 15 to 20 min. at 60°C.
Shigella spp.: Death within one hour at 55°C.
Escherichia coli: Most die within one hour at 55°C; and within 15 to 20 min. at 60°C.
Endamoeba histolytica: Thermal death point is 68°C.
Taenia saginata: Death within 5 min. at 71°C.
Trichinella spiralis larvae: ineffectivity reduces as a result of one hour exposure at 50°C; thermal death point is 62 to 72°C.
Necator americanus: Death within 50 min. at 45°C.
Brucella abortus or *suis*: Death within three minutes at 61°C.
Micrococcus pyogenes var. *aureus*: Death within 10 min. at 50°C.
Streptococcus pyogenes: Death within 10 min. at 54° C.
Mycobacterium tuberculosis: var. *hominis*: Death within 15 to 20 min. at 66°C; or monetary heating at 67°C.
Mycobacterium diptheriae: Death within 45 min. at 55°C.

Source: Composting: A Study of the Process and its Principles. C.G.Golueke. Rodale Press. 1972.

Collection of the Drums

When the drum is full, its contents are levelled with a stick before it is filled with ashes. Seal off surface with a layer of clay and put lid on (Ministry of Health, Viet Nam 1968).

Once the drums have been filled and capped at each household, it is desirable that they be picked up by a person hired specifically for the task. Community wide collection of excreta drums ensures that most of the community does not come in contact with the excreta.

Handling of the filled barrels requires some skill and considerable strength. Collection is probably easiest in the winter when a skidoo and sled can be used to haul the barrels to a centralized treatment site.

A steel two-wheel cart (see Figure 15) may be used to move the barrels from inside the home.

The metal plate at the front end of the cart is very thin and flush with the ground. In the upright position, the cart may be kicked under the edge of the barrel, tilted back and rolled away.

Such carts are presently used to move radiators and pianos (up and down stairs), both of which are heavier than a filled barrel.

Two people are able to transport the drum up and down stairs by sliding the cart at a 45° angle along its vertical supports.

Figure 15 Two-Wheeled Steel Cart

Choosing a Centralized Treatment Site

The treatment site should be located on 'high' land where the water table is relatively low. Do not use a depression or bog area where saturation of the soil with water is likely.

In selecting a site, look for an area large enough to contain a few garden plots. It may be necessary to clear the area of trees first (tree growth is usually more pronounced on higher, better drained lands). Clear only the minimum area necessary, as the remaining forest can be used in the elimination of greywater (plus urine) (See section 6 Greywater Disposal).

Anaerobic Treatment Process For Northern Ontario

The filled drums are collected at the treatment site where they will be left to undergo anaerobic decomposition for one year. Table 16 indicates the number of barrels and storage area required by various sized communities.

Table 16 Community Size, Drums and Storage Area

No. People in Community	No. Drums Filled Per Year	Storage Area* Required (square feet per year)
50	25	9' X 9'
100	50	12' X 12'
200	100	17' X 17'
300	150	21' X 21'
400	200	25' X 25'
500	250	27' X 27'
600	300	30' X 30'
1000	500	39' X 39'

*Assume width of drum is 3 feet

The drums are arranged in a square so as to minimize heat loss (see Figure 16) during biological activity. Paint tops of all barrels and the sides of the outer barrels black. This will increase the efficiency with which the drums absorb radiation from the sun and heat up.

Figure 16 Place drums close together to prevent unnecessary heat loss.

No data appears to exist on minimum air temperature required outside the drum to allow the internal temperature to increase sufficiently to permit decomposition.

In Northern Ontario, air temperature increases above freezing in April and remains so until November (see section 2.1 Climate). It is not known whether 5 months of temperatures above freezing would permit internal drum temperatures to increase sufficiently. This must be tested in the field.

During the 3 warmest months (June, July and August), average monthly temperatures vary from 13°C to 17°C. It must be remembered that, in the summer, the length of insolation is longer here than in southern Ontario. Longer insolation would permit the blackened barrels to absorb radiation for a longer period each day in the summer.

It might become necessary to increase air temperatures around the drums. This could be achieved by constructing a greenhouse over the drum storage area.

The greenhouse could be constructed locally using spruce poles for the frame. Clear polyethylene (plastic) sheeting could be used to cover the frame (see Figure 17). This system would be entirely passive, and function much the way a cold frame does in rural Ontario.

It is strongly suspected that enclosing drums in a greenhouse would more than adequately increase drum temperatures to permit decomposition. Internal temperatures probably increase to the point where most pathogenic organisms are destroyed.

After one year of winter storage and summer decomposition in the drums, the material should be removed to a nearby site designed to be the community garden.

5.1.3 Re-introducing The Community Garden

Until more than a decade ago, the growing of some garden vegetables, especially potatoes, was still common on Indian communities.

At present, virtually all fruits and vegetables are flown in from outside. At Big Trout and Kasabonika (two points visited by this author), it was observed that tinned fruits and vegetables were twice the price of those in southern Ontario.

It makes little economic sense to fly in tinned vegetables and fruits packed in water when air freight charges are calculated on the basis of weight (and water is heavy, even in tin cans).

Relying almost exclusively on tinned products contributes severely to the garbage problem. It takes a long time for a tin can to decompose in the northern environment.

Futhermore, the nutritional value of tinned products is substantially less than for fresh ones.

Re-introduction of the communal garden would lessen the dependence of the Indian on the White Man's tinned goods. Furthermore, it would provide employment to some members of the community.

Although the growing season is short, this factor is probably not as limiting as soil condition (see section 2 Biophysical Environment).

Soils tend to be shallow, clayey and often waterlogged. A soil suitable for cultivation must have a good mix of humic material and sand. The sand permits easy drainage. The humic material enhances soil porosity, allowing greater infiltration of air and water to plant roots.

The addition of humic material (compost) to the non-porous clay soils is vital in Northern Ontario for successful gardening.

To safeguard against transmission of pathogens, composted feces should be plowed into a garden and not used to grow harvestable crops that year.

Survival times of pathogens in the soil in temperate climates is given in Table 17 . Pathogens survive longer at low temperatures. Dysentry bacilli survive as long as 135 days at subzero temperatures. Fecal coliforms suffer 90% reduction in 3 or 4 days in summer and in 13 or 14 days in winter (Golueke, 1977).

Table 17 <u>Survival Time of Various Pathogens in the Soil and on some Plants</u>

Organism	Survival Time
Ascaris ova (soil)	Up to 7 years
Salmonella (soil)	29 t0 70 days
Cholera vibrio (spinach)	22 to 23 days
Endamoeba histolytica	8 days
Coliforms (on grass)	14 days
Hookworm larvae (soil)	6 weeeks
Leptospira (soil)	15 to 43 days
Polio virus (water)	20 days
Salmonella typhosa (soil)	74 days
Shigella (tomatoes)	2 to 7 days
Tubercle bacilli (soil)	6 days
Typhoid bacilli (soil)	7 to 40 days

Source: Golueke, 1977 from Pound, C.E. and R.W.Crites: "Nationwide Experiences in Land Treatment," in <u>Proceedings of Conference on Land Disposal of Municipal Effluents and Sludges</u>, Rutgers, USEPA, 1973.

While the compost/soil mixture is lying fallow, it is desirable to plant it with a crop that won't be harvested. (green manure). Leguminous crops such as alfalfa, red clover, sweet clover, soybean and cow pea make good green manures (fallow crops) in that they introduce nitrogen to the soil, and can grow on poor soils such as clay. Next spring, the fallow crop is plowed under and the garden is ready for its first crop plant. Addition of peat (abundant in the north) would further enhance the humic layer.

Figure 17 demonstrates a scheme that may be used for the garden.

In the first year, raw feces is composted in the greenhouse structure. In year 2, this compost is applied to the first plot and a fallow crop is grown. By year 3, plot 1 is ready to be planted with a harvestable crop such as potatoes, and plot 2 receives this year's compost. And so on......

Once the composted material is removed from the barrels, they are ready for re-use as privy drums.

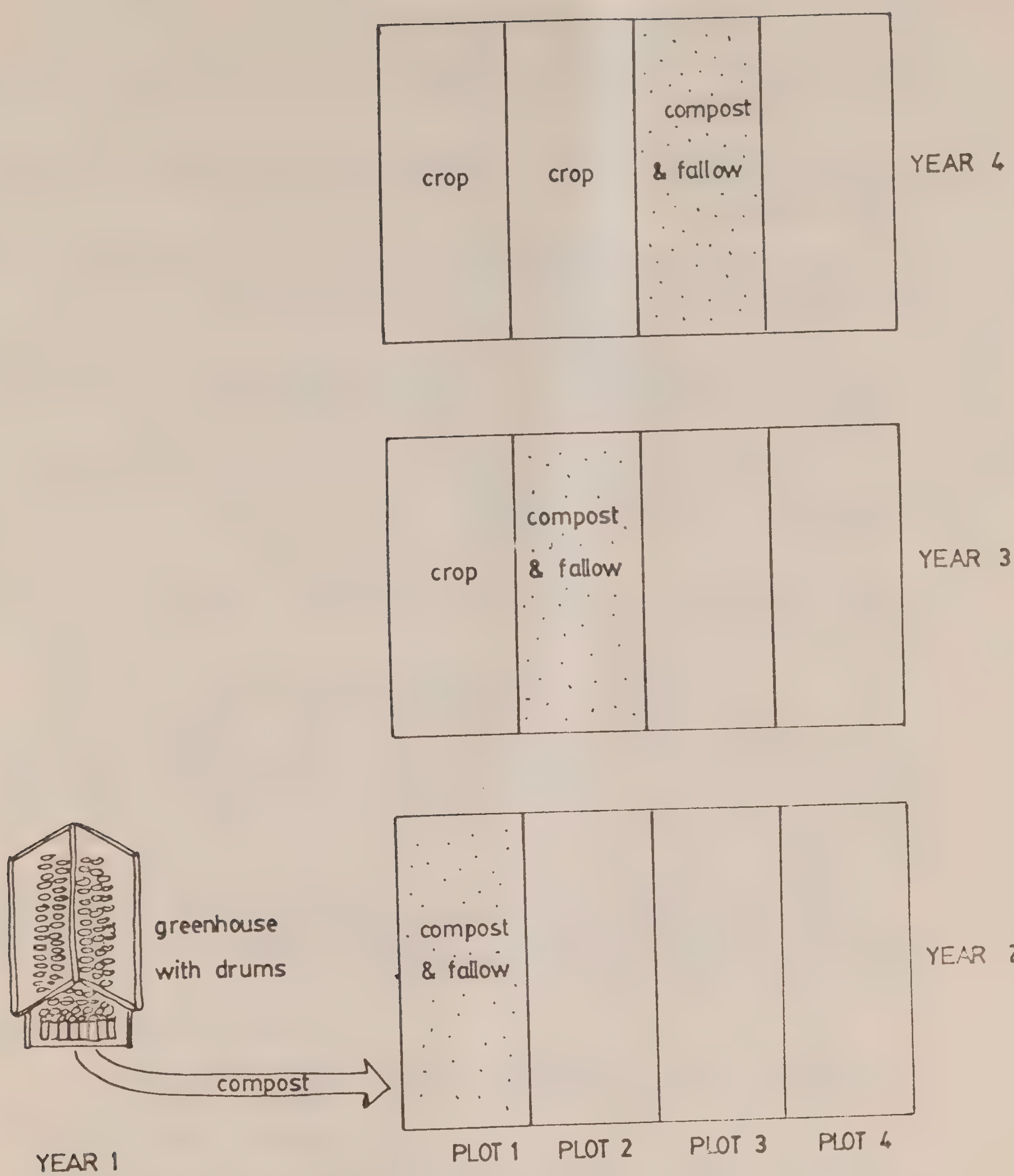


Figure 17 The composting site (greenhouse with drums) is located near a site suitable for the development of several garden plots. The greenhouse is a log and plastic covered structure.

5.1.4 Improved Outhouse

Suitability of the Outhouse

Outhouses (also know as privies or pit latrines) function as a receptacle in the ground for urine and feces.

In southern Ontario, outhouses are permitted only in those remote areas where at least 3 feet of clay extend below the ground surface.

Feces are intended to be trapped in the clay-sided hole and undergo gradual anaerobic decomposition. Urine seeps through the clay very slowly, or is evaporated.

Outhouses remain a relatively sound disposal method for those sites where thick clay soils predominate, and where the water table occurs below the bottom of the privy pit.

Outhouses are not suitable in waterlogged areas since continuous movement of nutrients and pathogens will occur through or above the ground.

Very coarse, sandy soils are also not suitable since they would permit easy access of pathogens and nutrients to nearby bodies of water.

Improvements in Outhouse Design and Use

A common problem with outhouses in Northern Ontario is their tendency to accumulate rain and melting snow into the decomposition pit. Drier conditions in the pit are expected to reduce the amount of flies, and hence reduce transmission of pathogens (via the flies) (Jackson et al, 1978).

Water draining into the pit can be averted to a large degree by building the outhouse crib (wooden foundation) above ground, and then banking earth around it (see Figure 18) (Jackson et al, 1978).

Installation of a vent would permit foul smelling vapours to escape. It is important that the vent have a cap preventing rain or snow from falling into the pit.

Or, alternatively, a functional window could be installed which is opened as desired to exchange the air in the privy. Addition of wood ashes (see Section 5.1.2 Anaerobic Composting) to the pit after each use facilitates composting and lessens foul odours.

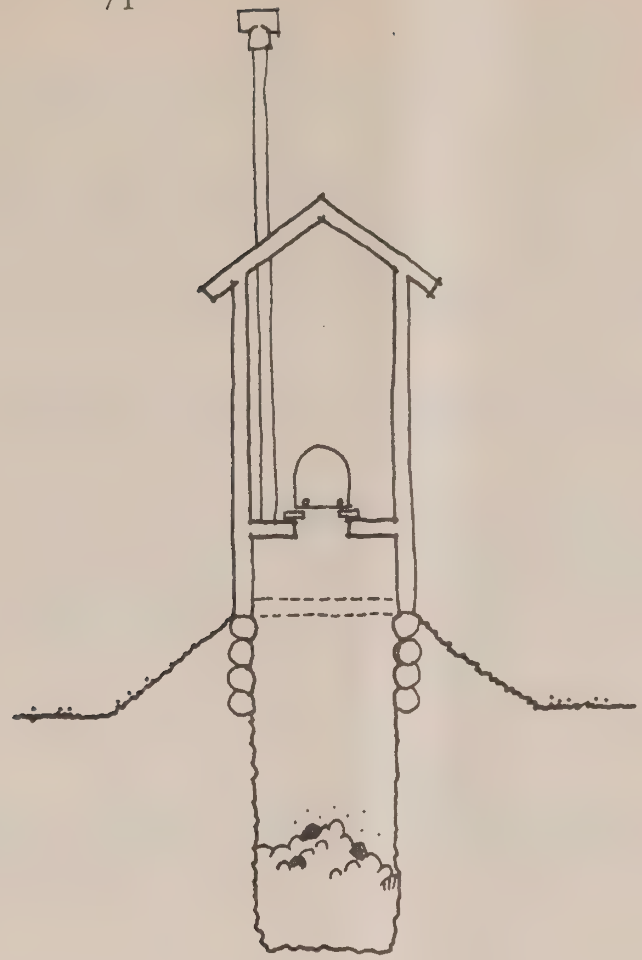


Figure 18 Improved outhouse with raised, bermed crib; vent stack and seat with lid.

Source: User's Making Choices. T. Jackson et al, 1978.

It was observed (during the winter) that outhouse doors frequently did not close properly. Construction of the door and sill was such that snow became trapped between the door and the stop. When this happened, the outhouse door no longer closed. Open doors flapping in the wind result in doors getting blown off.

Redesigning the door so that the bottom edge is raised a few inches above the snow line would allow for easier closing of the door.(see Figure 19).

Redesigning the door frame so that snow at the bottom of the door will not block its closure is desirable.

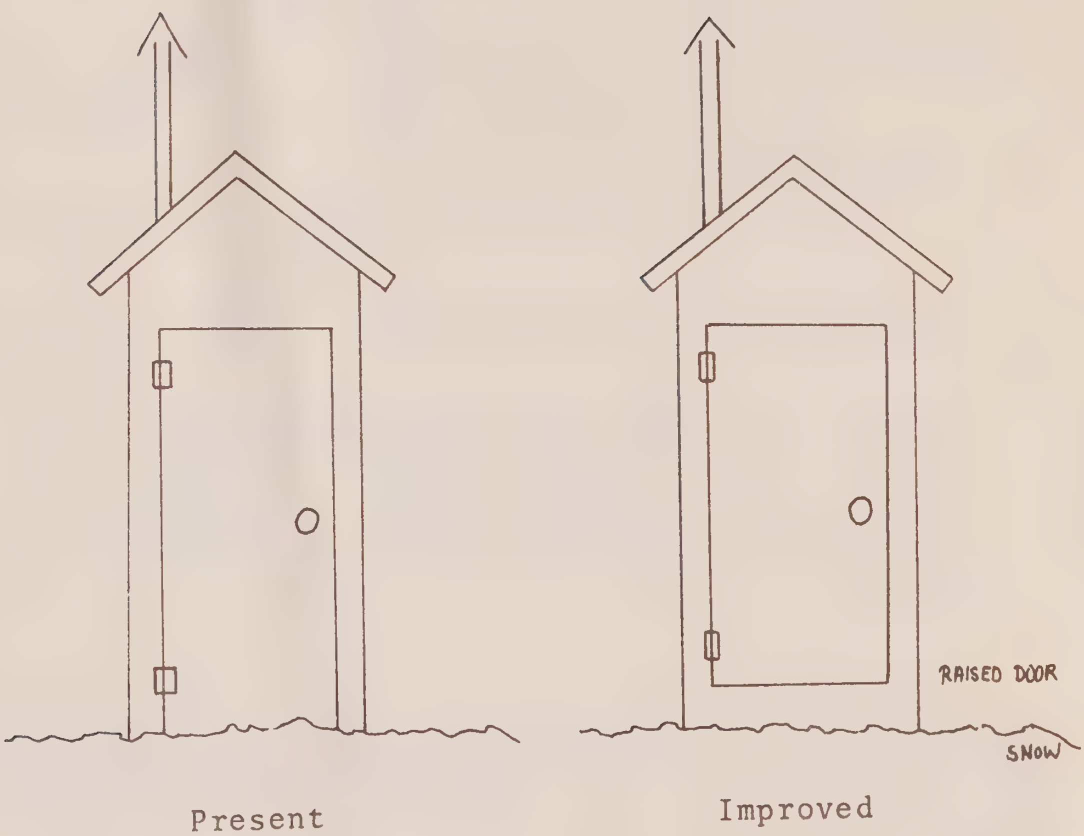


Figure 19 On left, outhouses at present get snow trapped between door and house. By raising door opening as at right, snow will not prevent closing of door during winter.

5.2 Appropriate High-Cost Alternatives

5.2.1 Outhouse with Liner and Pump-out

Unlike the drum privy design (see section 5.1.1 Drum Privy), this system does not require separate collection of feces and urine.

Body wastes are collected directly without using water as a transport medium. Stored wastes are collected bi-annually in their undiluted form.

This alternative has been developed by Rybczinski of the Minimum Cost Housing Group (school of Architecture, McGill). The system includes an impermeable liner for the outhouse pit, a method of evacuating the contents of the liner, and final treatment of the collected waste (see Figure 20).

The outhouse may be free standing or may be attached to the house.

The pit of the outhouse plus liner functions to store body wastes until that time when they can be pumped out into a transport tank. The wastes are then taken to a centralized treatment area.

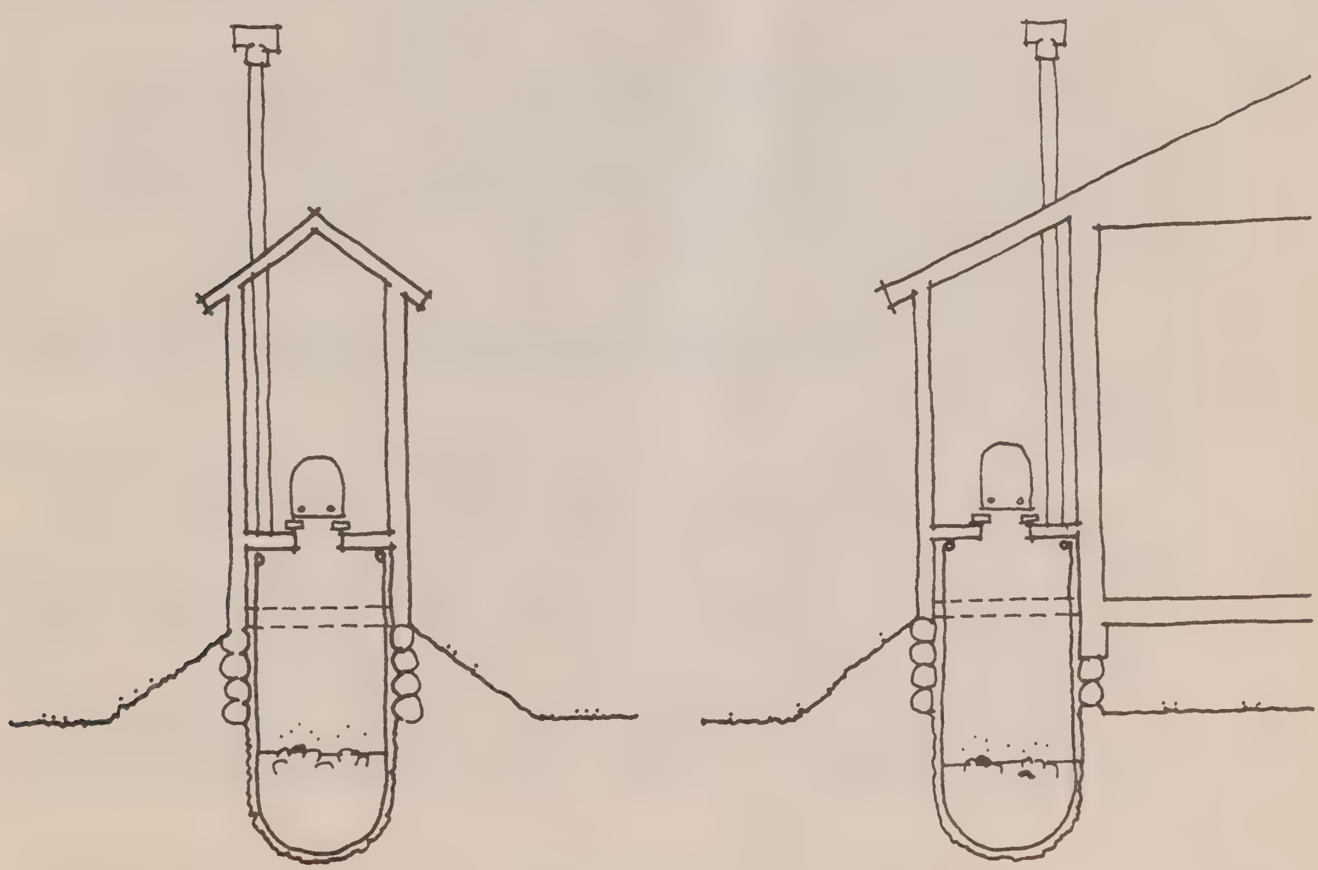


Figure 20 Showing outhouse plus liner and outhouse plus liner attached to house.

Source: User's Making Choices. T.Jackson et al. 1978.

The Liner

It is estimated that a family of six will produce about 80 ft^3 (2.2 m^3) of feces and urine per year (Rybczinski, 1978). Feces and urine can be pumped out only when in the non-frozen state, ie after spring thaw and before fall freeze up.

Minimum capacity for a family of 6 is 50 ft^3 (1.4 m^3). This translates to a pit dimension of 3' X 3' X 6' deep (Rybczynski 1978).

Difficulties arise where soils are shallow and underlain by bedrock. In such conditions, the pit dimension must be altered, or more pits constructed. Where bedrock is close to the ground surface, this alternative is not suitable.

The outhouse plus liner design is suitable in areas of clay. Because clay compacts together, a six foot hole dug in clay will maintain itself. Where soils are sandy and coarse, there will be a tendency for soils to collapse inward, decreasing the volume of the hole. Shoring would be necessary.

Rybczinski suggests a PVC-coated nylon reinforced bag as the least expensive solution to containing the waste inside the hole (about $60 per unit, 1978). A tank produced from two 45 gallon drums welded together is estimated to cost close to $100.

Removal and Transport of Wastes

Because the material inside the pit is semi-solid, the pump which evacuates it must be of large enough diameter to accomodate the solids moving through it. Rybczinski (1978) recommends a diaphragm pump be used (such as the Monarch 73-EDB with gas motor 8.8 HP, 3" diameter hose, 66 gpm; cost is about $2500).

Some of the larger communities have roads and vehicles. In these communities, existing vehicles such as trucks for pumping out septic tank sludge, might be used to haul away wastes.

Most communities, however, lack roads and such vehicles. Futhermore, the random arrangement of houses makes vehicle access to each house difficult.

In these communities, the cost of a sewage collection truck system would entail not only the purchase of the equipment, but also construction of roads.

In such communities, although operating costs could be met by the community, capital costs are prohibitive, unless subsidized externally.

Treatment of Wastes

See section 5.2.3 Central Treatment of Wastewater.

5.2.2 Holding Tank and Wastewater Collection by Truck

This alternative is based on the collection of household wastes from kitchen sinks, lavatories and toilets into a holding tank. This holding tank is emptied by a collection vehicle and taken to a treatment/disposal facility.

Although not in use in northern Ontario, this sytem is prevalent in the North West Territories where the provision of 'basic sanitation services' is subsidized by the Territorial government. 'Basic sanitation services' for truck systems are presently set at 10 gal/person/day (45 L/person/day).

The Holding Tank

The holding tank is located on or beneath the floor of the house so that wastewater from the kitchen sink, lavatory and toilet may drain into it by gravity flow.

The tank must be constructed with a large man hole with removable cover permitting clean out atleast once a year. It must be well insulated, kept within the heated portion of the building and/or heat must be added using heating coils or circulating hot water to prevent ice formation (Water Pollution Control Directorate, 1979).

Sizing of the holding tank must be done in conjunction with the community to be serviced to establish the desired rate of water use.

Data from numerous communities in the North West Territories indicate that houses with trucked water delivery but without internal plumbing typically use 10 L/person/day (2.2 gal/person/day) (Cameron, 1979). This relates well to observed water use at Big Trout Lake (water hauled individually) of 9 to 14 L/person/day (2 to 3 gal/person/day) (Jackson et al, 1978).

To put these numbers into perspective, average per capita water use in Ontario is 295 L/person/day (65 gal/person/day)!

Assume that the present rate of water use and wastewater generated (in northern Ontario Indian communities) were to remain the same at about 2.5 gal/person/day (11 L/person/day). In one week, a family of 6 would consume 487L (105 gal) of water. If wastewater collection were to occur 1 time per week, the minimum size water tank required would have to be 500 L for this family. However, it is prudent to have a storage capacity of 1000 L in the event that the collection vehicle encounters difficulties.

Collection by Truck

A rubber-tired truck would make a less expensive collection vehicle than a tracked vehicle. Tracked vehicles have a higher capital cost, higher operating and maintenance cost, and are slower than rubber-tired trucks (Water Pollution Control Directorate, 1978).

Unless the settlements have roads (few do), and have roads that are cleared in the winter, it is necessary to use a tracked vehicle.

This vehicle must be equipped with a tank, heater, pump and hose. The size of the truck will depend on the sizes of the tanks in the houses, and on the distance to the treatment site. At present, tanks of 2000 to 5000 L (500 to 1100 gal) are used on the hauling vehicles.

More detailed information regarding trucked excreta disposal can be found in the Cold Climate Utilities Delivery Design Manual, Water Pollution Control Directorate, Environment Canada, 1979.

Costs

Big Trout Lake is a dispersed Indian community in Northern Ontario. Its population in 1978 was 632 people (Ontario Ministry of Northern Affairs, 1979). The number of Native houses was 136 in 1978 (Jackson et al, 1978). A trucked water supply and wastewater collection system is being advocated for this community.

The annual cost to operate a sewage pump-out vehicle is estimated to be $61,000/ year (Cameron, 1979). Based on a water use of 15 L/person/day (3.3 gal), the cost to service these homes with sewage pump-out is $46,000/year. Given a water use of 45 L/person/day (10 gal), the cost to service these homes would be $108,000/ year (Cameron, 1979).

In addition to these costs, one must take into account the money required to purchase, transport, insulate and install the wastewater holding tanks in each home. Another cost to bear in mind is the cost of treatment of the wastewater once collected.

High capital and high operating costs make this system an expensive alternative, but it is not as prohibitively expensive as installing sewers to all homes.

5.2.3 Centralized Treatment of Wastewater

Facultative Lagoon

In a facultative pond, the upper layers of water (the water can separate into thermal layers if there is little physical mixing) operate aerobically, while the lower layers are anaerobic (Goldstein, 1973).

Where sufficient land area and suitable soil conditions exist, facultative lagoons are probably the most cost-effective alternative for cold regions (compared to aerated lagoon systems, mechanical treatment, etc.) (Water Pollution Control Directorate, 1979).

Facultative lagoons function as retaining pools in which microbial and algal activity are responsible for purifying the wastewater.

The system is essentially passive. Mechanical aerators are not part of the design. Movement of wastewater from one cell to the other is by gravity flow where the terrain is suitable. Where necessary, wastewater must be pumped from one lagoon to the next (see Figure 21). Insulated electric heat-traced pipe permits the flow of wastewater through the system in the winter (see Figure 22).

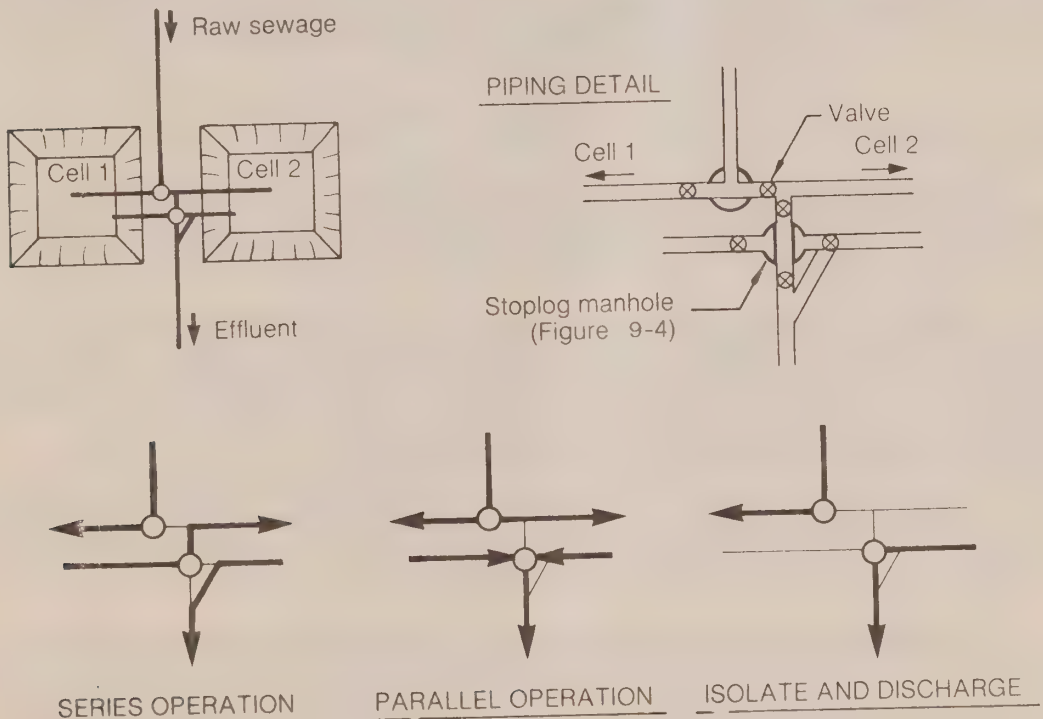


Figure 21 Two-cell Facultative Lagoon

Source: Cold Climate Utilities Delivery Design Manual. Water Pollution Control Directorate. Environment Canada. 1979.

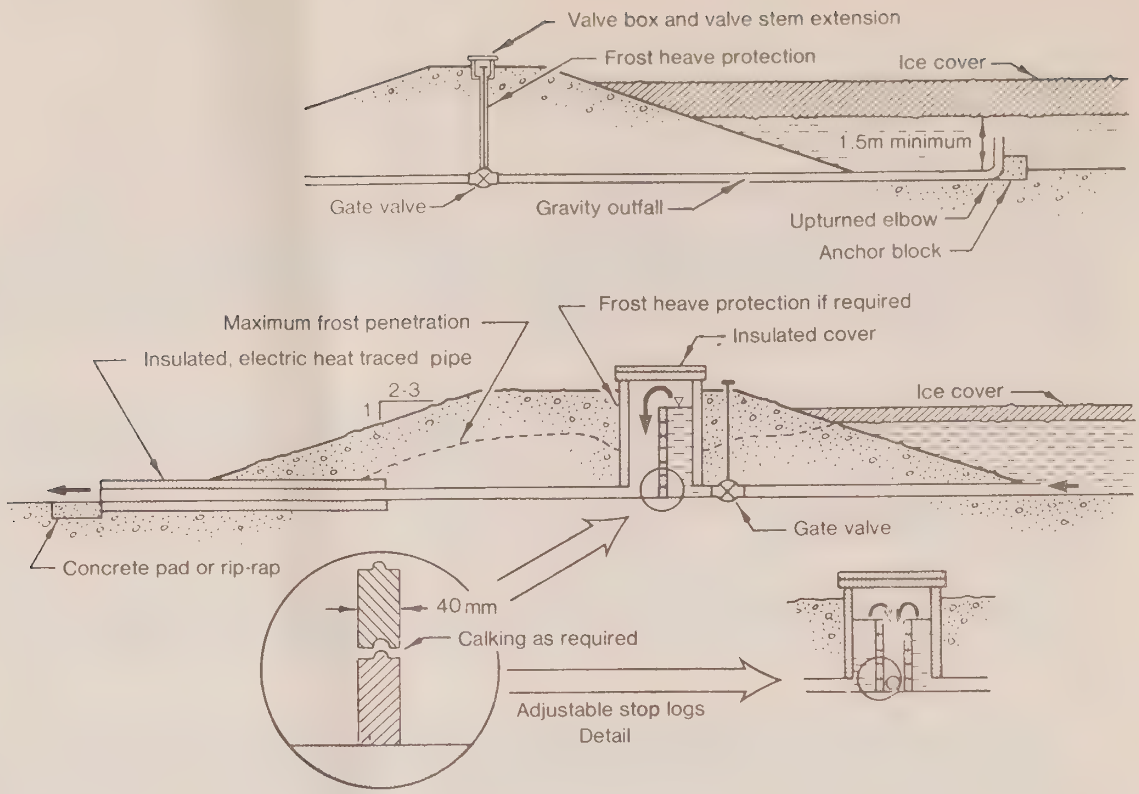


Figure 22 Designing for protection against freeze-up of piping permits year round transfer of wastewater from one lagoon to the other.

Source: Cold Climate Utilities Delivery Design Manual. Water Pollution Control Directorate. Environment Canada. 1979.

The simplicity of the facultative lagoon, and the lack of an abundance of mechanical parts greatly reduces the chance of collapse of the system through mechanical failure.

Passive lagoon systems require a greater land area and/or longer retention time than aerated lagoons. The lagoon system should have a minimum of two cells, permitting full year retention of the wastes in one cell, and accumulation of the current year's wastewater in the other.

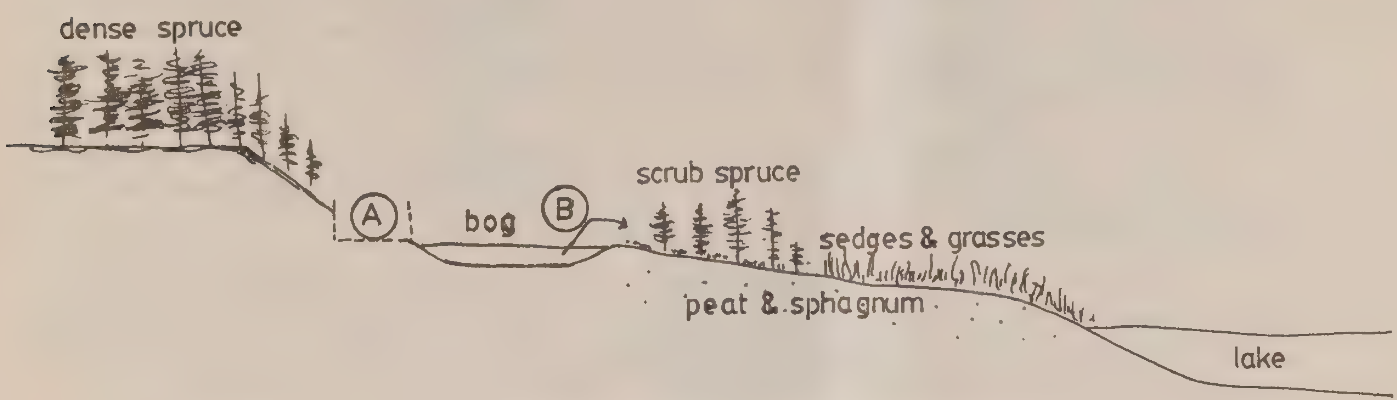
During the winter, it is believed that the lagoon functions primarily as a settling and holding tank, and that most biological treatment occurs during the summer.

Research on psychrophilic (cold temperature bacteria) indicates that more biological decomposition might be occurring at the low temperatures of northern lagoons than previously anticipated (Henry, 1974). Further research in this area might yield treatment alternatives designed for low temperature processes.

5.2.4 Natural Lagoons

The soils of northern Ontario tend to be clayey and impervious to water, making them suitable for lagoons.

Bogs and depressions are common. The area adjacent to the community should be investigated to determine whether any 'natural' lagoons can be adapted to retain and treat sewage (see Figure 23).



(A) Construct cell to hold and settle fresh wastewater. Gravity feed cleared wastewater to existing pond.

(B) Through out spring and summer, gravity feed or pump wastewater to sphagnum and spruce area, sedges and grasses or to whatever vegetation grows here.

Figure 23 Natural Sewage Lagoon System

The advantage of such a system is that it requires considerably less construction and excavation than a conventional lagoon.

Because the vegetation through which the wastewater flows takes up nutrients, this effluent contributes much less to eutrophication of lake water than a more conventional lagoon.

By using the existing soil/peat layer, and the adjacent vegetation in the treatment of wastewater, it is anticipated that the size of the retention lagoons can be reduced. How much size reduction is possible must be determined by actual experimentation in the field.

Ecological observations indicate that indigenous plants are more suited to their climate and soil conditions than introduced species. Hence, use of an existing bog/marsh system ensures greater success than introducing exotic plants to take up nutrients.

5.2.5 Marsh-Pond Treatment

Marsh-pond treatment makes use of a series of constructed ponds and marshes to settle out solids, reduce BOD (biological oxygen demand), take up plant nutrients and reduce pathogenic organisms.

Raw sewage enters one of two (or more) receiving ponds (see Figure 24). Solids settle to the bottom of the pond and undergo anaerobic digestion. The resultant sludge is cleared as necessary and applied to a field in preparation for crop culture in the future, or is applied to a forested region remote from the community.

The size of the receiving pond is based on the amount of wastewater generated as well as the length of time wastewater must accumulate in them during freeze up.

After a ten-day retention period (summer) (Zimmerman,1979) the clarified wastewater is released into a marsh. Transpiration by plants reduces water volume. More solids are settled, BOD is reduced further and nutrients are taken up by the plants.

The effluent trickles by gravity flow into a secondary receiving pond where microbial decomposition continues. The wastewater is treated to tertiary treatment level in the final marsh area. Phosphates in the effluent of a properly functioning system are less than 1 ppm (this meets the Ontario standards for phosphate removal in the Great Lakes area - an area of stringent phosphate control).

It is estimated that an area of 50 acres (20 Ha) containing a marsh associated with a shallow pond of approximately equal area (50 acres) could deal effectively with domestic sewage for 10,000 people (Woodwell, 1977).

Table 18 indicates approximate land area required to construct a marsh and pond treatment system, based on community size. For Northern Ontario, pond area should be somewhat greater than indicated in Table to accomodate storage of wastewater during the more lengthy winter.

Table 18 Marsh-Pond Area Relative to Community Size

No. people in community	Marsh-pond area required (acres (hectares))	
300	3	(1.2)
400	4	(1.6)
500	5	(2.0)
600	6	(2.4)
800	8	(3.2)
1000	10	(4.0)

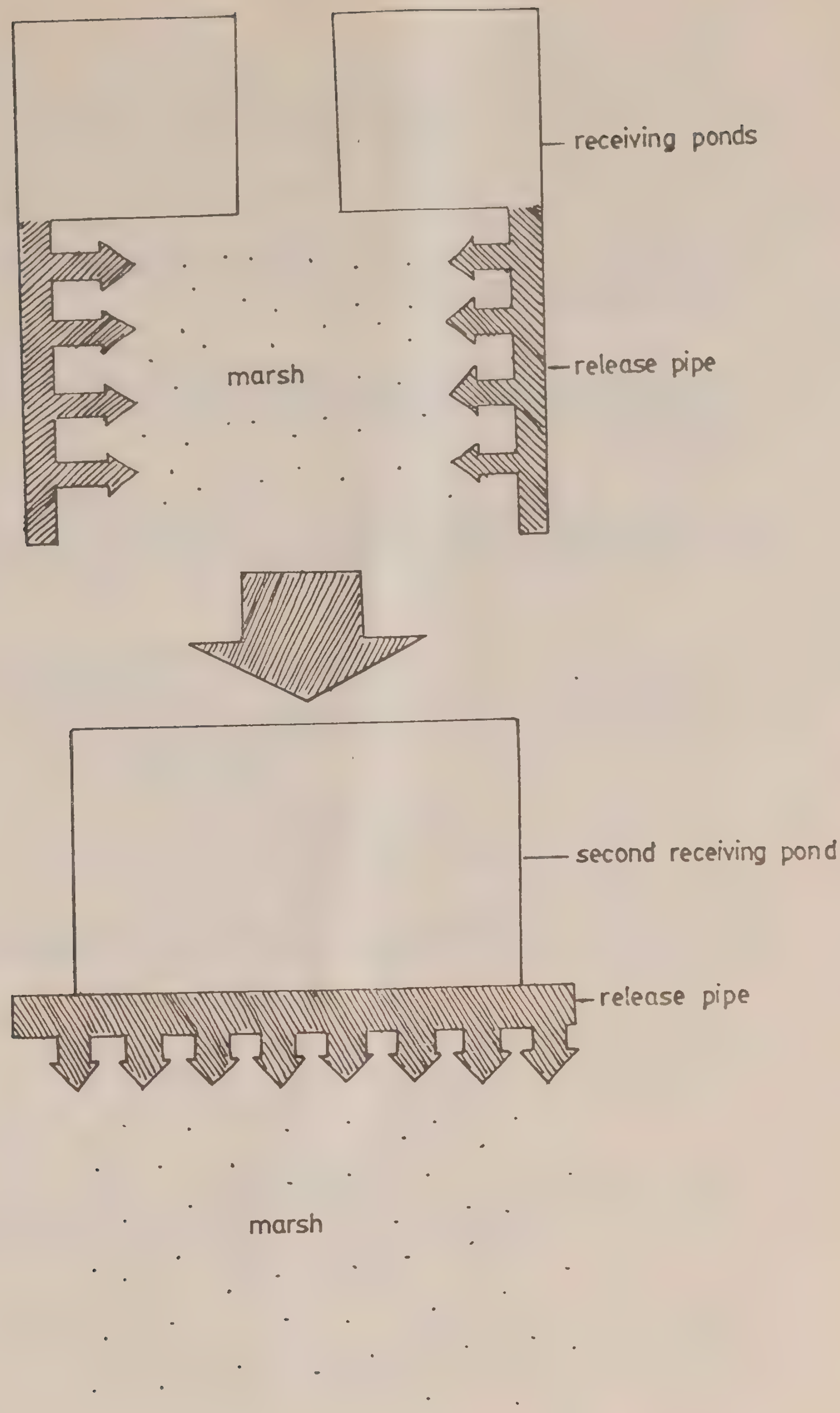


Figure 24 A schematic diagram of a wetlands sewage treatment site.

The first two receiving ponds function largely to allow solids to settle out. The clarified effluent is released from perforated pipes. The wastewater then moves slowly through the marsh by gravity flow into the second receiving pond. Final marsh polishes effluent further.

Source: User's Making Choices. Appendix E by A.P.Zimmerman. 1979.

5.2.6 Aerobic Composting Toilet (large)

Aerobic composting toilets may be classified into two types according to the size of their composting tanks - large and small. This section deals with the large composting toilet. For a description of the small composting toilet, see section 5.3 Inappropriate Technologies).

The large composting (also called mouldering) toilet is a passive system that does not require supplementary heat if the tank is placed in an area at room temperature (ie in a basement).

The large size of the composting chamber (about 4' x 5' x 9') ensures that the compost pile is large enough to maintain the heat generated by microbial activity (see Figure 25).

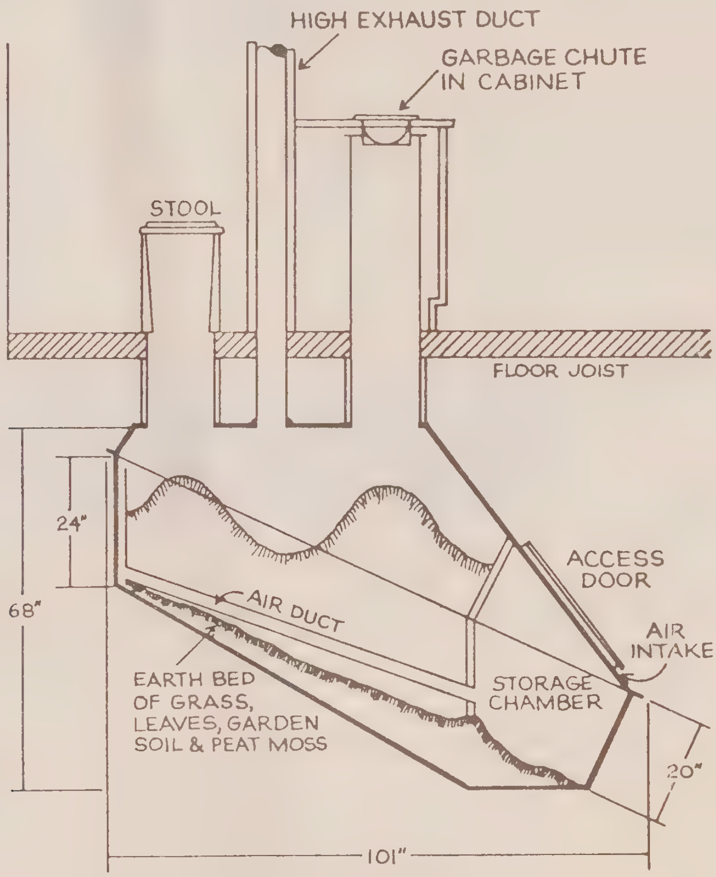


Figure 25 Cross section of a large composting toilet showing its characteric sloping bottom and chute for biodegradable garbage.

Source: Good-bye to the Flush Toilet. C.H.Stoner. 1977.

In a properly functioning unit, the internal temperature characteristically is about 40°C (optimum temperature), but increases to 50°C and 60°C for a short period before heat released by decomposition is sufficient to destroy most microbes and pathogens. The dry crumbly compost falls through a grate to a storage chamber.

Large composting toilets usually include one or more toilet chutes and a separate kitchen chute through which biodegradable wastes fall into the composting tank.

Large composting toilets are preferable to the small units. Once the microflora and microfauna are established in the tank, the compost heap is less vulnerable to change in use pattern than the smaller units.

Operational energy demands and costs are lower for a large unit. The only energy required is that to run a 20 to 40 watt electric fan, however, the electric fan can be replaced with a passive unit.

Large composting toilets are a suitable alternative in that they do not require water to transport away body wastes. Electricity is not required (although preferred to run the fan). Treatment of wastes occurs on-site, eliminating the need for a centralized treatment facility.

It must be recognized that this alternative is suitable to northern communities only under certain circumstances.

The composting tank must be kept in an area of room temperature for microbial activity to occur. This necessitates that the home have a basement, or be a two storey structure.

Native homes characteristically have no basement and are 1 storey buildings. Perhaps the future will see construction of two storey homes, at which point this alternative becomes feasible.

This option is listed in this report as a high cost alternative. Although operational costs are negligible, the unit itself costs $1,500 to $2,000. Transportation costs to fly in this large pre-manufactured unit are high.

For composting to proceed properly, organic kitchen and garden scraps must be added regularly to the tank. In southern Ontario where 40% of residential garbage is biodegradable (food and yard wastes), use of a mouldering toilet is a good way to reduce throw away garbage.

In northern Ontario, very little of the garbage produced is biodegradable (most fruits and vegetables are tinned).

To compensate for the lack of biodegradable kitchen and yard wastes entering the composting tank, it would be necessary to add other organic material rich in carbon. Sphagnum moss is abundant, as is peat. These materials should be added regularly to facilitate decomposition and to soak up excess urine.

5.3 INAPPROPRIATE ALTERNATIVES

5.3.1 Central Sewers and Mechanical Treatment

Central sewers and mechanical treatment are a multi-million dollar expense, even in the more southerly latitudes. In northern climates, costs are so exorbitant as to make piped water and wastewater transport to all homes unreasonable.

Unit construction costs for 1977 in northern environments appear in Table 19 . Although sewering costs are heavily subsidized by the provincial and federal government, most municipalities are responsible for the first $1,400 of sewer hook-up costs (Inter-provincial Conference of Ministers with Responsibility for Northern Development, 1979).

Table 19 UNIT CONSTRUCTION COSTS (1977)

Item	Cost in Place*	Remarks
On-surface utilidors	$400 to $1,200/m	Does not include excavation; depends on backfill material
Above-surface Utilidors	$600 to $1,700/m	Cost depends on foundation
Sewage grinder pump and sump	$3,200	
Manholes	$1,500 to $2,000	Does not include excavation
Lift stations	$18,000	Depends on size; does not include excavation
Rock excavation	$50 to $75/m^3	
Normal excavation	$20 to $30/m^3	
Plumbing a house	$2,100	Toilet, sink, lavatory
House holding tanks	$3,500	For water and waste

* All costs vary with transportation.

Source: Cold Climate Utilities Delivery Design Manual. Water Pollution Control Directorate, Environment Canada. 1979.

It is interesting to take Kasabonika as an example of how unaffordable central sewerage is in remote northern communities.

Given a 3 % annual growth rate, the 1978 population of Kasabonika (377 people, Ministry of Northern Affairs, 1978) is anticipated to be 400 people in 1980. Assuming 5 persons per household, the number of native homes in 1980 is predicted to be 80.

Cost of plumbing a house was estimated at $2100 in 1977 (see Table 19). Given a 10% inflation rate, the 1980 cost of internal plumbing is estimated to be $2,800.

For the 80 homes of Kasabonika, internal plumbing costs are predicted to be $223,600 (in 1980).

If the policy that each household is responsible for the first $1,400 of sewer hook-up charges were applied to northern native communities, then total cost to the community for sewer hook-up would be $112,000.

Immediate out of pocket expenses to the Native community for sewer hook-up and internal plumbing would be $335,600. (this cost does not take into account the millions of dollars to be paid by provincial and federal governments for capital and operative costs of the central sewer and treatment plant).

The 5 year Capital Management Plan of Kasabonika (see Table 20) is not unlike those of many Native communities in Northern Ontario in that there is a conspicuous lack of a category of spending for water/sewage servicing.

Table 20 KASABONIKA: FIVE YEAR CAPITAL MANAGEMENT PLAN

Project Description	1979/80	80/81	81/82	82/83	84/85
Band Office	$19,800	--	--	--	--
Kayahna Air	$18,000	--	--	--	--
Housing	140,800	108,000	109,000	132,000	112,000
" " repair	--	16,000	16,000	10,000	10,000
Electrificat.	--	20,000	20,000	10,000	5,000
Truck/van	--	15,000	--	--	--
Roads	--	19,200	5,000	6,400	5,000
Warehouse	--	--	8,400	--	--
Tractor	--	--	--	--	26,400
Total	$178,200	178,200	158,400	158,400	158,400

Source: Kasabonika Band Office, Kasabonika. 1979.

Even if water/sewer servicing were to be allocated under the 'housing' category, insufficient funds exist within the community to pay for internal plumbing and sewer/water hookups.

In Table 20, it can be seen that the total allocation of local government capital funds to Kasabonika for 1980 is about half ($178,200) that required simply for internal plumbing and sewer hook-ups.

Central sewers are not an affordable solution to the sanitation needs of native communities.

Mechanical treatment plants such as aerated lagoons are not suitable to the climate of northern Ontario, as evidenced by the numerous freeze-ups where they do occur.

Furthermore, these alternatives require a very trained, very specialized support staff to maintain such systems. Lack of such a support staff contributes to untimely breakdown of the system.

5.3.2 Septic Tank and Absorption Field

The septic tank must be buried below the zone of freezing to ensure that wastewater is not frozen during the winter, blocking effluent movement to the absorption field (see Figure 26).

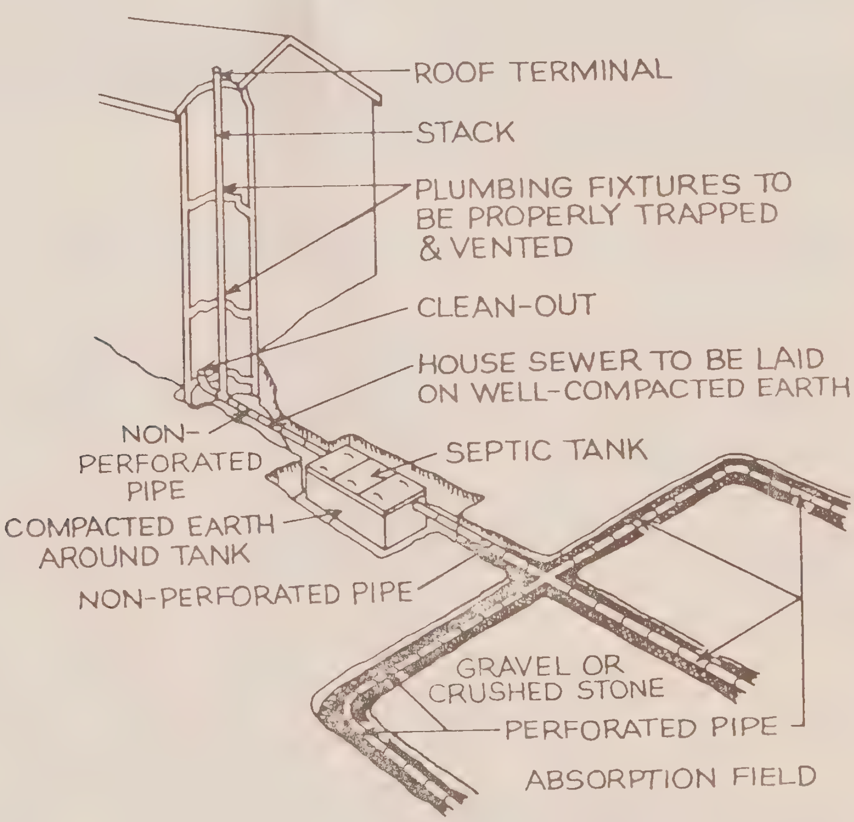


Figure 26 The Septic Tank Sewage Disposal System

(Source: Goodbye to the Flush Toilet. C.H.Stoner, 1977.)

The absorption field is functional only when water leaving the distribution lines is able to percolate through the soil quickly enough to prevent accumulation of water in the absorption trenches.

Thus the septic tank and leaching field is a poor choice in areas of clay soils because of the impermeable nature of clay.

Failing systems have been reported at the schools of the following Native communities: Sandy Lake, Lansdowne House, Grassy Narrows, Kingfisher Lake, Big Trout Lake, Deer Lake, Poplar Hill, Sachigo, Webequie and Kasabonika (as reported in consultant reports). It is likely that similar difficulties exist in other communities, however, this information is not readily available.

Absorption fields are not suitable in areas with a high water table. Instead of being treated aerobically by microbes in the ground, the wastewater tends to contaminate the groundwater and potential drinking water supplies.

Properly functioning septic systems may be adequate where soil conditions are right. This is rarely the case in Northern Ontario.

Septic systems do not significantly reduce phosphates (or other plant nutrients) in the wastewater percolating through the soil. Because Native communities in Northern Ontario are built at the water's edge, movement of plant nutrients into the lake may eutrophy a lake sufficiently to degrade the drinking water supply as well as fish habitats.

5.3.3 Aerobic System

Presently, aerobic systems such as the BioDisc are under serious consideration as an alternative waste disposal method to the failing septic tanks at schools in several northern Ontario communities.

The BioDisc is a complete above ground aerobic sewage treatment system that can serve 5 to 500 people.

Operation is based on the slow rotation of discs alternating between the air and the sewage (see Figure 27).

The treatment system was designed for southern climates where winters are not as severe or as long. To make this unit function in the north, each unit would have to be adequately insulated and heated.

This is not a suitable alternative for Native communities because costs are prohibitive if each household were to have one. If a community BioDisc were considered, then central sewers or a trucked system would be required to transport wastewater to it.

Again, breakdown of the system would probably require that an expert be flown in to fix such a technologically complex system.

Maintenance costs can be anticipated to be high in northern Ontario. Sludge must be removed two to three times a year (Asdor Ltd., publication 112). A special truck is required to remove the sludge which must be treated subsequently.

Figure A

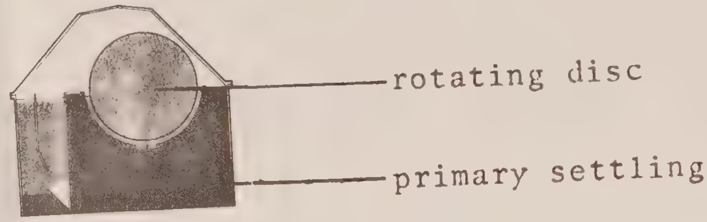


Figure B

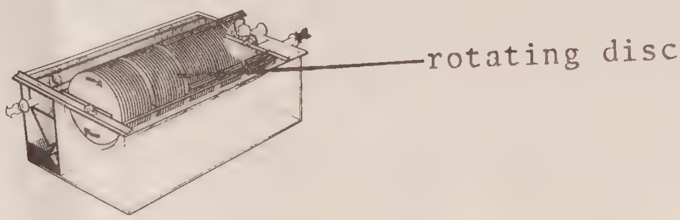


Figure C

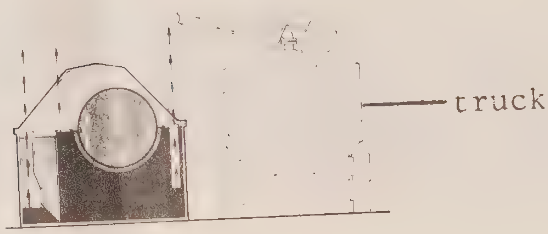


Figure 27 BIODISC (A ROTATING BIOLOGICAL CONTACTOR)

Figure A shows end view. Micro-organisms which coat the rotating disc biologically treat the settled wastewater. After biological breakdown, the wastewater is allowed to settle again (Figure B). Sludge must be removed 2 to 3 times each year (Figure C).

(Source: <u>BioDisc: The Complete Sewage Process</u>. Asdor Ltd. Publication 112)

5.3.4 Chemical Toilet

Chemical toilets are essentially plastic buckets with a toilet seat and lid (see Figure 28). Chemicals are added to reduce odours. Wastes are collected in the toilet bucket and must be taken elsewhere for treatment.

The chemicals added are usually lye or phenols. Although these chemicals reduce odours, they create problems later in the treatment process by inhibiting biological decomposition.

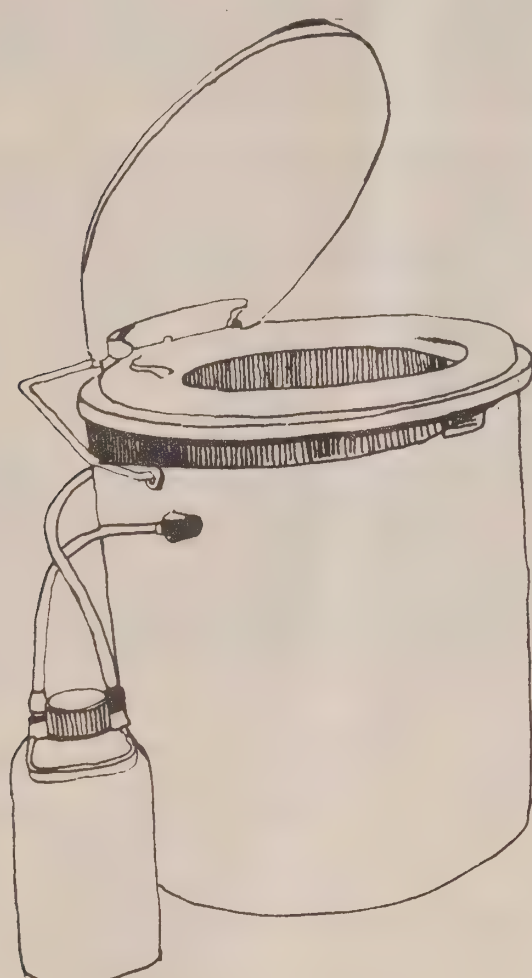


Figure 28 A CHEMICAL TOILET

(Source: Stop the Five Gallon Flush! W.Rybczynski & A.Ortega. 1973)

5.3.5 Small Composting Toilet

The small composting toilet offers complete on-site treatment of body wastes . The end-product is compost which may be added to the garden as a soil conditioner and fertilizer.

No water or sewer hook-ups are required, which make them attractive in remote areas.

Electricity is required to operate a venting fan as well as a heater. When properly functioning, the fan evaporates urine through a vent (see Figure 29).

A heating element in the unit promotes decomposition of the feces by maintaining temperature of the feces pile at the optimum for microbial breakdown (35°C to 40°C). Some units have a special pasteurization chamber to heat the finished compost to 70°C, thereby destroying most pathogens.

Experience in the north with these units has shown them to be unsatisfactory. Small composting toilets are vulnerable to change in user habits, particularly to overloading with urine. Reports of strong odours and fan breakdowns are numerous.

The small composting toilets are not recommended for use in native homes because they do not function properly under excessive or irregular loading (multi-day visits by friends and family are common at Native homes).

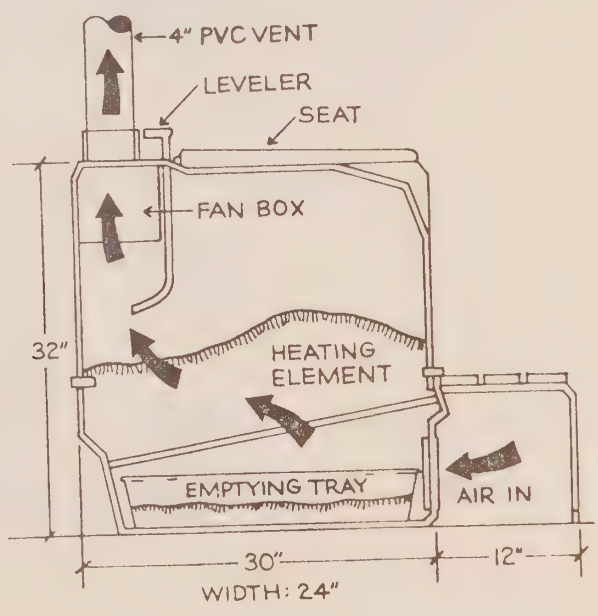
Most Indian homes do not have electricity,making this alternative inappropriate. The continuous energy requirements by small composting toilets makes them wasteful of energy resources.

Units cost $700 to $900. Transportation costs are also substantial. The capital and operating costs of these composting toilets makes them unaffordable to most families.

Figure 29

Cross section of a small composting toilet.

(Source: Good-bye to the Flush Toilet C.H.Stoner. 1977)



5.3.6 Incinerating Toilet

The incinerating toilet burns body wastes at very high temperatures, reducing them to a sterile ash (see Figure 30).

The incinerator may be fired by gas, oil or electricity. Some models require a paper liner to be put in the bowl after each use.

The incinerating process consumes large amounts of energy. Before the wastes can be burned, considerable energy must be spent to evaporate water from the urine and feces. During this evaporation phase, some odours may be given off.

Although incineration neatly eliminates the waste problem, it is not an appropriate alternative for widespread use in Native homes. Capital costs are high ($800 to 1,000). Operating costs are even higher because fuel must be flown in to operate them.

Incinerating toilets are wasteful of energy and organic material resources.

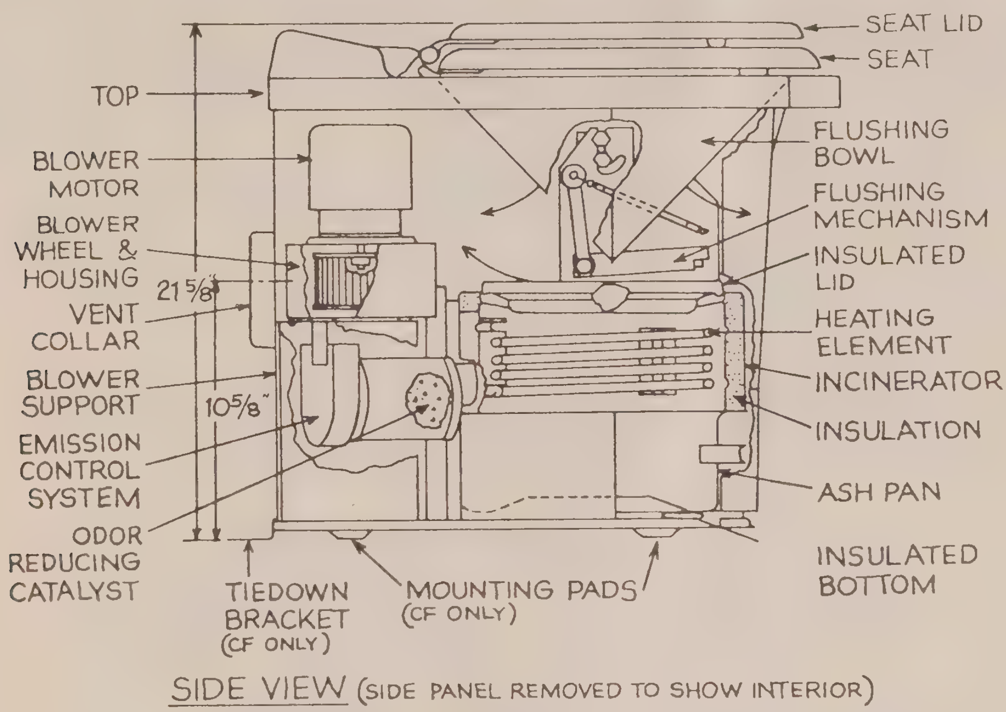


Figure 30 The Incinerating Toilet

(Source: Goodbye to the Flush Toilet. C.H.Stoner. 1977.

5.3.7 Biological Toilet

Biological toilets make use of enzymes and bacteria (aerobic and anaerobic) to digest (liquify) body wastes. A package of freeze-dried enzymes and bacteria must be added each week.

By liquifying the excreta, no residue (sludge) remains. Treatment is complete. The effluent is repudiated to be odourless, clear and free of pathogens.

No water or electricity is required. The commode itself must be kept at room temperature to ensure enzygmatic breakdown is maintained.

In Native homes, temperatures vary considerably within the house during the winter, depending on whether there is someone at home keeping the wood stove burning. During the night, temperatures drop considerably as the fire goes out. It is anticipated that this will interfere with the functioning of this type of toilet system.

Units cost about $600 to $800. Operating costs are probably low, requiring only the purchase of bacteria and enzymes.

Odours and clooging problems have been reported.

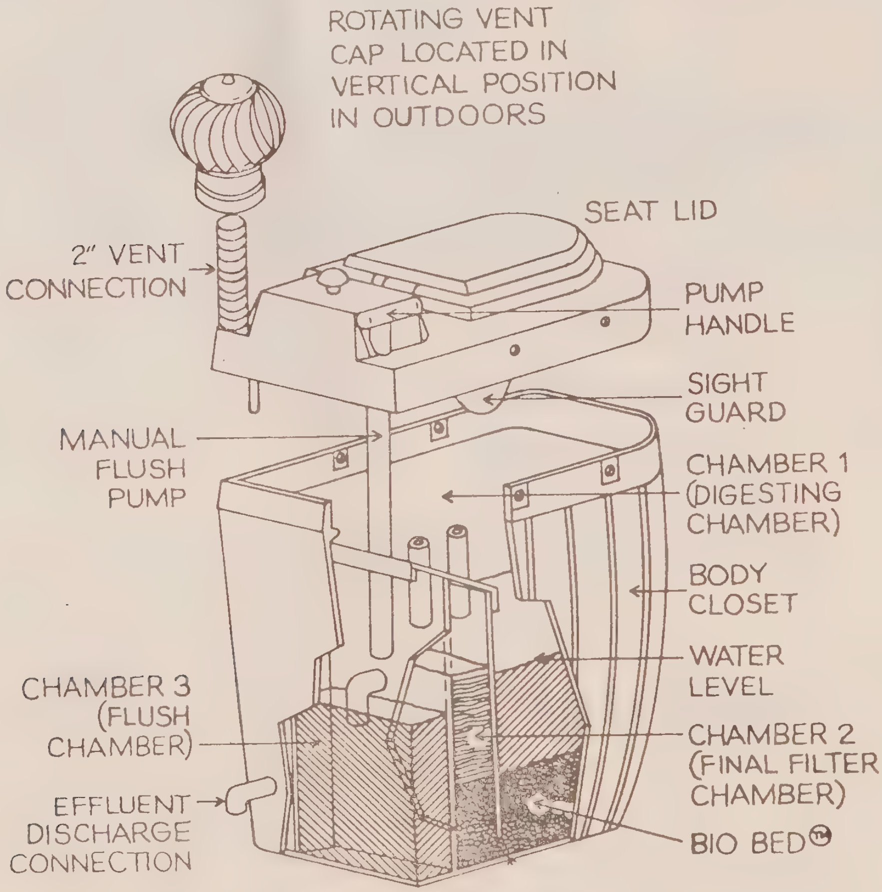


Figure 31 Cross section of a biological toilet.

(Source: Goodbye to the Flush Toilet. C.H.Stoner. 1977.

6. GREYWATER (PLUS URINE) DISPOSAL

The excreta disposal alternatives recommended in this report all make use of a waterless toilet system.

The conventional outhouse, outhouse with liner and the aerobic composting toilet options collect both urine and feces. For these alternatives, household wastewater from the kitchen, washing area and laundry (known as greywater) must be collected and disposed.

The drum privy alternative requires separate collection of feces and urine. Feces is collected in 45 gallon drums and transported to a central treatment site. Urine is added to wastewater from the kitchen, personal washing area and laundry, and is collected and treated separately.

6.1 Greywater Characteristics

The characteristics of greywater at Native homes has not been documented yet.

Because Native people use less water per capita, the concentration of pollutants in the wastewater is expected to be higher.

Average pollution loads from rural households in non-Native settlements appear in Table 21.

TABLE 21 AVERAGE POLLUTION LOADS FROM RURAL HOUSEHOLDS

Source of wastewater	BOD (g/p/d)	SS (g/p/d)	N (g/p/d)	P (g/p/d)
Kitchen sink[1]	8.3	4.1	0.4	0.4
Automatic dishwasher[1]	12.6	5.3	0.5	0.8
Bath/shower[1]	3.1	2.3	0.3	<0.1
Laundry[1]	14.8	10.9	0.7	2.1
Greywater subtotal	38.8	22.6	1.9	3.4
Toilet[2]	20-28	27	10-18	.7-1.9
Total	58.8 to 66.8	49.6	11.9 to 19.9	9.1 to 5.3

[1] Segragation and Treatment of Black and Graywaters. R. Siegrist. Small Scale Waste Management Project, U of Wisconsin, Madison. 1976.

[2] Home Plumbing Fixture Waste Flows and Pollutants. R.Laak. University of Connecticut, Storrs. 1972.

In Table 22, the average pollution load from native households is predicted on the basis of Table 21 .

It is anticipated that Native people produce much lower pollution loads in kitchen wastewater than in non-Native homes. Vegetables are frequently heated over a wood stove in the tin can they were purchased in. This eliminates cleaning of pots and subsequent entry of organic matter into the wastewater.

Meals are generally not elaborate in preparation, and hence relatively few dishes are made dirty. Tinned meats leave little mess.

Cleaning liquids and soaps are used, but because the total number of dishes dirtied are so few, total use of these cleansers tends to be low.

Bathing occurs about once a month. Teeth, hands and face tend to be cleaned every day.

Table 22 assumes that pollution loading in wastewater from kitchen uses is one third that in non-Native homes, and that loading from personal washing and laundry is half that in non-Native homes.

Pollution loads from urine are based on composition of human excrement (Gotaas, 1956). Dry weight of urine (50 to 70 grams/person/day) is similar to dry weight of feces (35 to 70 g/p/d) (Gotaas, 1956).

Content of organic matter is similar, so one can assume both are contributing approximately equal BOD and suspended solids loads (loading for feces is slightly higher).

Nitrogen loading by urine is about 3 times that of feces. Phosphorus loadings are similar.

TABLE 22 ESTIMATED POLLUTION LOADS FROM NATIVE HOUSEHOLDS

	BOD g/p/d	SS g/p/d	N g/p/d	P g/p/d
Kitchen & personal washing	8.5	4.3	0.5	0.4
Kitchen, personal washing & laundry	15.9	9.8	0.9	1.5
Kitchen, personal washing & urine	~18.5	~17.3	~11.5	~1.4
Kitchen, personal washing, laundry & urine	~25.9	~22.8	~11.9	~2.5

Biological evaluations of greywater are rare. More study is required in this area to determine the degree of treatment required.

Bacterial characteristics of bath/shower/laundry wastewater appear in Table 23.

TABLE 23 TOTAL AND FECAL COLIFORM IN GREYWATER

		Mean No./100 ml
Bath/shower	Fecal coliforms	220
	Total coliforms	1100
Clothes wash	Fecal coliforms	1400
	Total coliforms	18000
Clothes rinse	Fecal coliforms	320
	Total coliforms	5300

Source: "Rural Household Wastewater Characterization". In: Home Sewage Disposal. Proceedings of the National Home Disposal Symposium. Chicago 1974.

Fecal coliform organisms in the bath/shower wastewater are relatively low. Fecal coliform counts in laundry wastewater are about 8 times that from the bath/shower.

In Ontario, the permissible concentration of total and fecal coliform organisms in public water supplies are 5,000/100 ml and 500/100 ml respectively (Water Pollution Control Directorate, draft report). The public water supply is filtered and chlorinated before consumed.

Bacterial investigations of urine appear to be non-existent. Dr. Golueke of the Sanitary Engineering Department of the University of California states that human urine "is a minimal health risk entity. That is, chances of catching anything from it are small" (Stoner, 1977).

Considerably more research is required to determine whether urine may contain any disease-causing micro-organisms.

6.2 Appropriate Low-Cost Alternatives

6.2.1 Seepage Pit with Sand Filtration

A seepage pit is a suitable alternative where water use is low. Wastewater is allowed to seep slowly through a gravel filled pit where microbial activity degrades the organic matter and takes up nutrients to a certain degree.

A seepage pit is suitable only where the soil is permeable enough to permit liquids to percolate through the soil at the same rate or faster than they enter the pit.

In Northern Ontario, seepage pits should be about 8 feet deep so that wastewater added in winter can drain into non-frozen ground. Pits should be 1 to 3 feet wide, depending on the volume of wastewater to be disposed of each day.

The ground water table should be no less than 4 feet below the bottom of the pit (Stoner, 1977) to prevent ground water contamination.

After the hole is dug, the cavity is filled with 3 feet of sand and 5 feet of gravel and broken rock. The drain pipe from the house can enter the pit from above or from the side.

A lid (wood, metal, concrete or tile) is placed over the pit to prevent silt from clogging it (see Figure 32).

To ensure that the pit does not become clogged with grease and soap, collect cooking grease in a tin for separate disposal. Do not use excessive amounts of soap in daily use. No solvents or substances toxic to microbial organisims should be dumped down the drain.

Conventionally, seepage pits are left as a reinforced open chamber (with no gravel) or they are filled entirely with gravel. Where wastewater does not contain urine, this is probably still an acceptable solution, especially if sand is not easily available.

Where sand is available, it is advocated that the bottom 3 feet of the pit be filled with it.

A study by Brandes (1974) indicates that 3 feet of sand (grain size D = 0.24 mm; uniformity coefficient Cu= 3.9) achieves almost complete removal of total and fecal coliforms in septic tank effluent applied at the rate of 70L/m /day. Fecal coliforms were reduced from 2,000,000/100 ml to less than 30/100 ml.

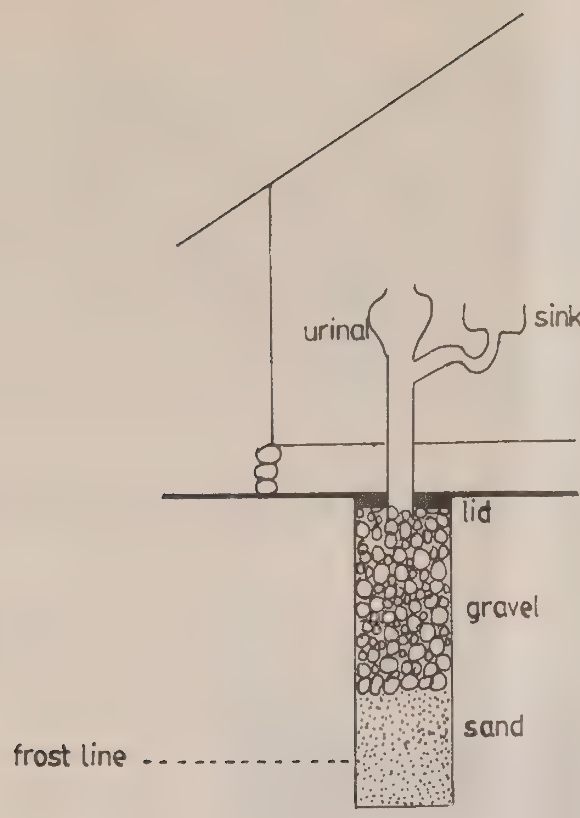


FIGURE 32 SEEPAGE PIT WITH SAND FILTRATION

The seepage pit may be dug adjacent to the house where the toilet room addition is to be constructed. Urine and greywater enter the pit directly beneath.

Where soil conditions are right, the seepage pit with sand filtration reduces organic matter loading, suspended solids and (most) pathogens extremely well.

The drawback of this system is that it will not remove much nitrogen and phosphorus from the percolating wastewater. If the adjacent body of water is a river or deep oligotrophic lake, nutrient loadings from seepage pits are probably insignificant.

In areas where lakes are more shallow and already vulnerable to eutrophication, it may be decided that the seepage pit alternative is not suitable.

Construction of the seepage pit is labour intensive. Actual materials costs are low, making it affordable to most families.

6.2.2 In-house Filtration

In-house filtration is an acceptable alternative for those homes built in vegetated areas with relatively good ground drainage. Although few trees exist around houses at present, some of the newer houses (ie at Big Trout Lake) were observed to be constructed on high ground and surrounded by trees.

This simple filtration method has been developed by Sim Van der Rym (1978). Wastewater is filtered through a series of materials in a 45 gallon drum (or other water holding receptacle).

By carefully designing sink and urinal heights, it is possible to make the wastewater flow by gravity to the wastewater-treatment room.

The greywater treatment area may be enclosed in a separate room (see Figure 6). Whereas the height of the toilet room floor might be higher than that of the rest of the house (see Figure 7), the height of the floor of the greywater chamber might be lower than the rest of the house.

The greywater room should be well insulated to retain heat. A vent or duct from the wood stove should connect to this room.

To construct the drum filter, fit a drainage pipe into the bottom of the drum. If cement is easily available, form a funnel shaped bottom around the drain. This permits more complete drainage but is not critical.

Place a layer of stones about one sixth of the way up the tank. Add another layer of medium gravel on top of this (also one sixth of total drum height). Add a layer of pea gravel (one sixth of total drum height) and fill container to top with sand (about 2 feet of sand) (see Figure 33).

A 45 gallon drum can safely filter about 25 gallons (110 L) of wastewater each day (Van der Rym, 1978).

Daily flows from a Native family of 6 are estimated to be less than 20 gallons (90 L).

Two alternating drum filters will work longer than one filter because the resting filter gets a chance to aerate and dry out. Two alternating filter beds will reduce maintenance. At the first signs of clogging, switch greywater flow to the resting bed (Van der Rym, 1978).

Add clean water to the filter drum occassionally to clear the filter. The top inch or two of sand should be replaced periodically (Van der Rym, 1978).

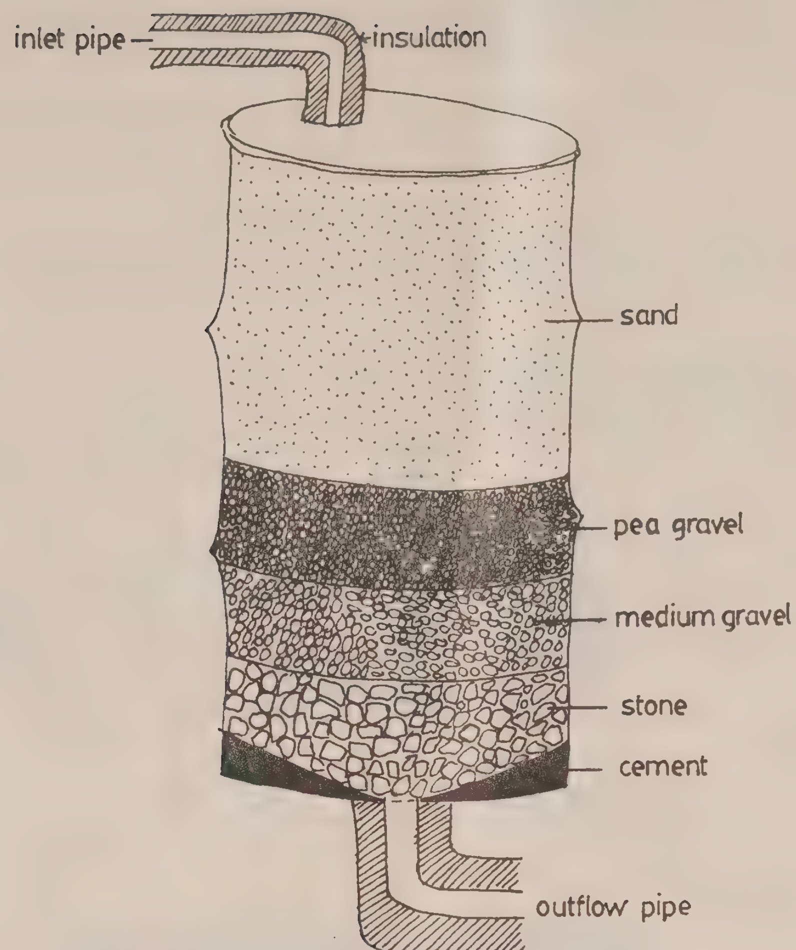


FIGURE 33 DRUM FILTRATION OF WASTEWATER

Much of the wastewater entering the filtration drum will be warm. Adding insulation to the incoming and outgoing pipe helps retain this warmth, further ensuring that filtration is successful during winter.

After: The Toilet Papers. Sim Van der Rym. Capra Press, Santa Barbara. 1978.

The filtered effluent will be greatly reduced in suspended solids, organic matter and coliforms. The effluent should be purified further to remove nutrients.

This is achieved by letting the effluent drain out of the house to where it will flow through vegetation such as mosses and spruces (see Figure 34).

FIGURE 34 Effluent from the drum filter flows overland through vegetated area outside house, and eventually percolates through soil and/or is evapotranspirated by the vegetation.

6.2.3 Individual Haulage and Disposal in Forest or Communal Seepage Pit

In some homes where wastewater generated is very low (ie few members in households, wastewater only from kitchen and personal washing) it may be decided to dispose of wastewater individually.

A household of two might produce no more than 5 gallons of wastewater each day, if it has access to a communal laundry/shower facility.

Greywater may be dumped in nearby woods or vegetated area, provided the water table is atleast 3 or 4 feet below the ground.

A communal seepage pit might be used as a disposal site for individually hauled wastewater (see Figure 35). Or perhaps the community vendor who supplies drinking water would dispose of wastewater.

As with the individual on-site seepage pit, the soil must be sufficiently permeable. The bottom of the pit should be 4 feet above the ground water table. Size of pit depends on quantity of wastewater it will receive each day.

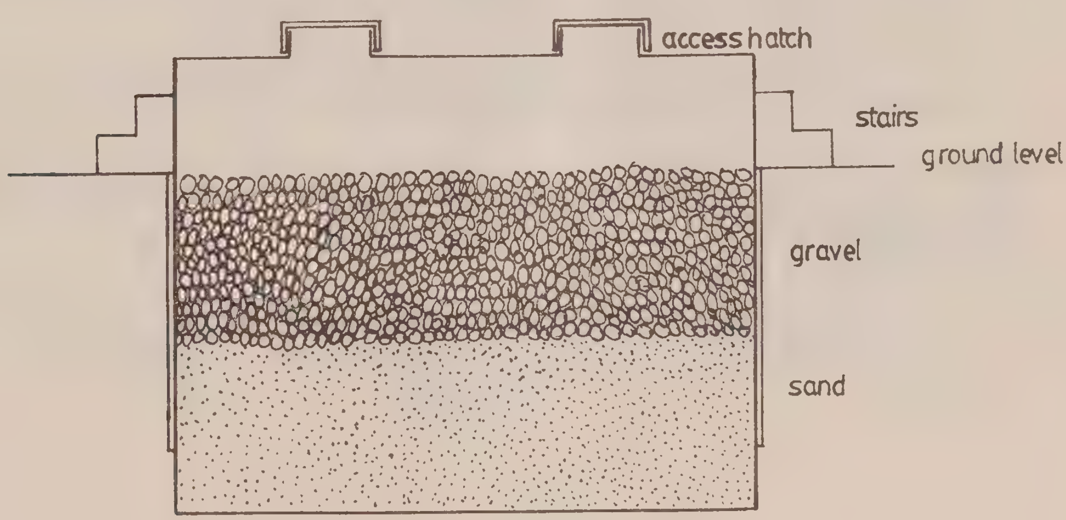


FIGURE 35 COMMUNITY SEEPAGE PIT

The housing of the pit may be constructed of wood and should be atleast 4 feet tall. Wastewater is dumped down an access hatch.

The pit should have plank or log shoring around the upper portion of the pit to prevent sides from caving in, and to hinder silting of the pit.

A wooden cover keeps snow and rain out of the pit. This cover should be 4 feet above the ground (in the winter, snow accumulates to a 3 foot height).

Access portals are hinged box-like covers. Wastewater is dumped into the pit through these.

6.3 Appropriate High-Cost Alternatives

6.3.1 Holding Tank and Vehicle Haul

Wastewater is collected in a tank on or beneath the floor of the house into which wastewater from the kitchen, lavatory and urinal drain by gravity. Once a week the wastewater is pumped from the holding tank into the collection vehicle.

Size of the holding tank depends on amount of wastewater generated. Wastewater holding tanks should be 400 L larger than the water storage tank provided (Water Pollution Control Directorate, 1979).

A family of six producing 15 L wastewater/person/day would require a 1000 L holding tank if wastewater is collected once a week.

It is necessary to provide structural support in the house where necessary to carry this additional load.

The tank must be constructed with a large manhole with a removable cover so that it can be cleaned and flushed out atleast yearly (Water Pollution Control Directorate, 1979).

The tank must be insulated and kept in the heated portion of the building, or/and heat must be added using heating coils to prevent freeze up (Water Pollution Control Directorate, 1979).

6.3.2 Disposal to Forest, Cropland or Marsh

Land application of wastewater (greywater or greywater plus urine) should be restricted to the spring, summer and fall when the ground is no longer frozen and permits vertical percolation through the soil.

Evapotranspiration by vegetation will be greater than in the winter, permitting greater loading of wastewater.

Nutrient uptake by plant material is anticipated to occur only during the plant's growth period.

In the spring, summer and fall, greywater may be applied directly to the receiving vegetation, at a rate which ensures proper filtration through the soil. Direct application of wastewater from the hauling vehicle would provide an economic benefit but might not be acceptable to those communities wishing virtually no contamination at discharge.

Saturation of the soil must be avoided because this might result in raw greywater running directly into the adjacent water supplies without having been treated in the soil layer first.

Wastewater collected in the winter should be stored in a man-made or natural lagoon until that time when it can be applied to the land (see Figure 36).

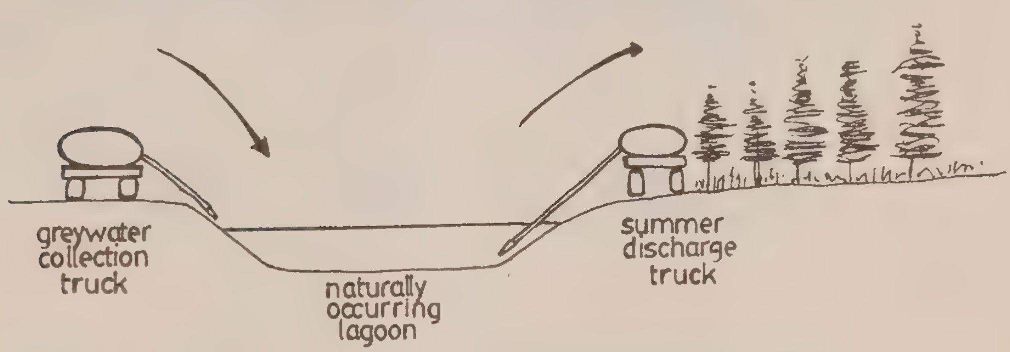


FIGURE 36 A naturally occurring pond/bog is used to store (or treat) greywater. Summer discharge requires haulage by vehicle or pump/pipe system.

A more costly alternative is to provide enough storage capacity to contain all wastewaters for a year, and then apply them to nearby vegetation (see Figure 37). This provides the greatest degree of treatment of any of the alternatives suggested.

The storage area functions as a facultative lagoon in which settling of solids, aerobic and anaerobic decomposition occur. The clarified effluent is then spray-applied to cropland and forests, or allowed to filter through a marsh for nutrient removal.

The lagoon plus land application alternative might be desired by large communities located on a small lake where environmental impact of pollution loading would be great.

In smaller communities situated on a large lake or river where the pollution loading is less and the capacity of the receiving environment is greater, direct application of wastewater to land vegetation in summer may be adequate.

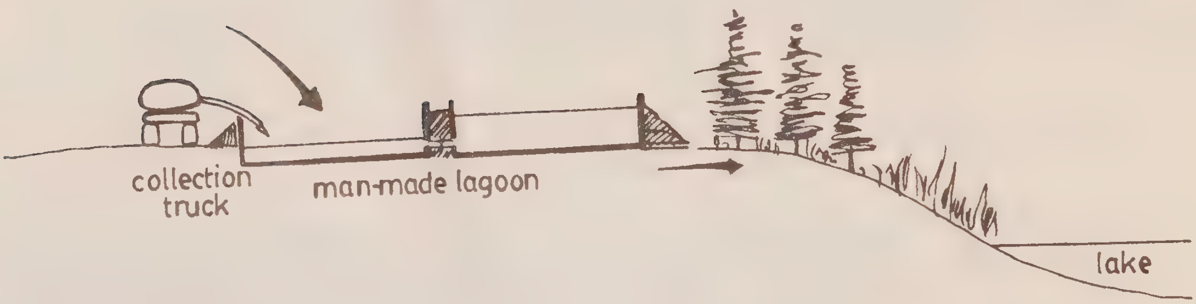


FIGURE 37 Two lagoons are constructed on high ground. One lagoon is receiving new wastewater. Treated wastewater in the other one is ready for spring discharge to the adjacent forest. The treated effluent moves by gravity flow.

Experimental application of primary-treated sewage effluent on land vegetation has demonstrated that nutrients in the sewage enhance plant growth (see Figure 38).

In experiments on Long Island, New York (Woodwell, 1977) four stages of plant succession were selected to receive the primary treated sewage. The vegetation stages were an agricultural field, an abondoned field, a stand of pine and an oak-pine forest. The objective was to test the capacity of these various ecosystems for absorbing the organic matter and nutrients in sewage, and for releasing clean water into the ground.

The experiments revealed that forests have a larger capacity for removing nutrients than the earlier successional stages (Woodwell, 1977).

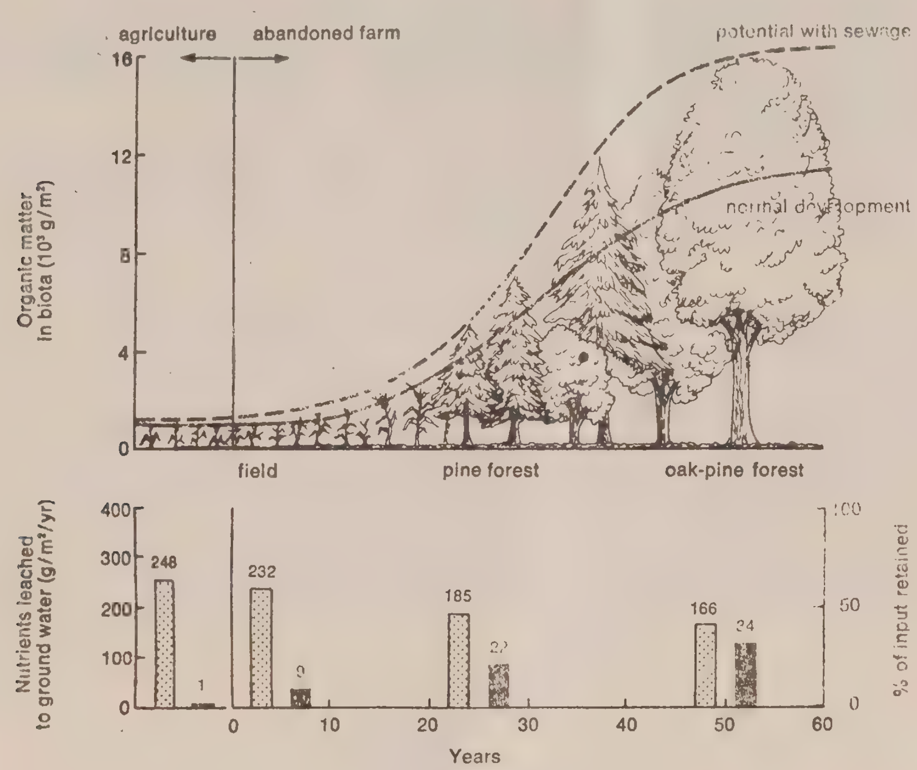


FIGURE 38 In the experiment by Woodwell, forest stands absorbed appreciably more of the input nutrients and released higher quality water into the ground water than did earlier successional stages. This serves as evidence that forests can serve as appropriate disposal sites for discharges of wastewater whose major contaminants have been removed elsewhere.

Source: "Recycling Sewage Through Plant Communities." G.M. Woodwell. American Scientist Volume 65 1977.

Application of greywater plus urine to Northern forested areas is anticipated to stimulate the growth of trees, as well as remove nutrients from the percolating wastewater.

Based on daily amounts excreted, urine contains 3 to 4 times as much nitrogen as feces, twice as much potassium and similar amounts of phosphorus (Gotaas, 1956).

Application of raw sewage or sewage sludge sometimes presents problems in that the large amount of solids tends to clog the soil. This problem is eliminated when applying greywater, particularly settled greywater to the land.

Application of greywater plus urine to plots of land being prepared for future gardening would add plant nutrients to the soil (see Figure 17).

Final disposal of greywater to a marsh (see section 5.2.5 Marsh-Pond Treatment) would remove plants nutrients from the wastewater, preventing accelerated eutrophication of the adjacent water supply.

7. GARBAGE

7.1 Appropriate Alternatives

7.1.1 Garbage Reduction

Not all garbage is equal. Some components of garbage are disposed of more easily than others. Although Native people produce less garbage per capita than other Canadians (see section 3.5 Garbage Disposal), they generate a higher proportion of difficult to dispose of objects such as tin cans.

The development of a community garden would reduce the need to buy vegetables in tin cans.

The feasibility of recycling cans should be investigated. Although perhaps not economically worthwhile at present, this may change in the future.

Re-introduction of community gardening would shift the composition of garbage to one with a higher per centage of easily degradable materials. Biodegradable garbage is a community resource which can be composted and returned to the community garden.

Another way to reduce garbage, especially paper and tin garbage, is to buy from bulk, much as occurs in co-ops and health food stores. Instead of purchasing goods in individually wrapped packages, one purchases as much as one needs from a big container in the store, and then stores the foods in jars on shelves easily accessible in the kitchen (see Figure 39).

This would eliminate excess packaging garbage, as well as initiate re-use of glass and plastic containers (perhaps even cans for dry goods).

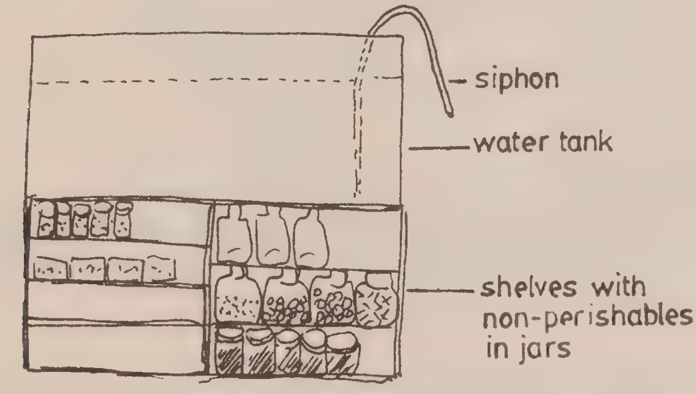


FIGURE 39 Bulk storage of non-perishable food products eliminates unnecessary packaging.

Although it seems probable that the local Hudson Bay store would not supply food in bulk, it is likely that Native people would set up their own shops in a co-op style.

In smaller communities where no Hudson Bay store exists, several individuals have stores (ie in Kasabonika, 3 small stores exist). These stores already tend to sell certain items in large quantities (flour in 50 pound bags) indicating a sensibility not very evident in the over-packaged products of the Hudson Bay store.

Dry goods could be purchased and shipped in plywood drums. The drums are placed in the store as is, lids are removed and a scoop is placed in each one. The individual scoops out as much as he needs into a bag and pays for it by weight (see Figure 40).

Introduction of dried fruits such as apples, apricots, pears etc. would make shipping costs cheaper per unit food item, as well as reduce packaging waste.

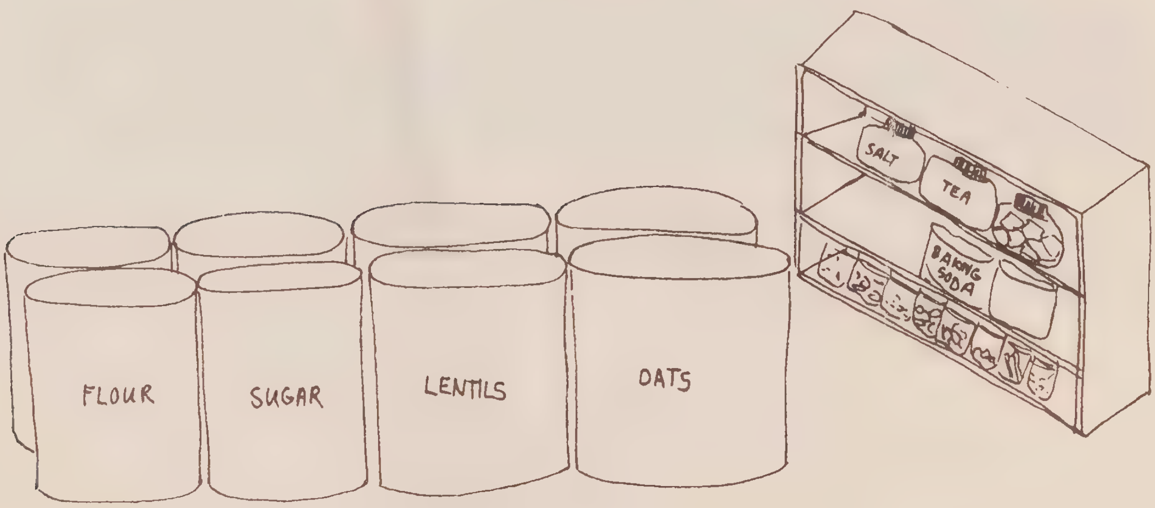


FIGURE 40 Selling non-perishable foods by weight from large containers reduces packaging wastes.

7.1.2 Community Garbage Collection

The larger communities operate a community wide garbage collection service. Lack of funds allocated to waste management in smaller communities puts the responsibility on individuals to dispose of their garbage.

It is desirable that a garbage collection system operate in each community, no matter how small. Garbage filled plastic bags should be stored in the vestibule or on top of the house, away from dogs.

Collection of garbage can be by truck in the summer, and by skidoo with sled in the winter.

7.1.3 Burning of Garbage

Plastic lined diapers do not degrade easily and should be burned to destroy pathogens. Wastes from the nursing station must also be burned.

It is desirable that cans be burned first to enhance degradation at the garbage pit.

Installation of commercially manufactured incinerators is expensive. A lower cost alternative is to burn garbage at an open burn site.

Use dirty engine oil (a disposal problem in itself) at the burn site to ensure complete burning of used diapers and other garbage. Burn garbage when it is dry, and in a dry area. If necessary, add dry firewood and wood scraps to keep the fire burning (see Figure 41).

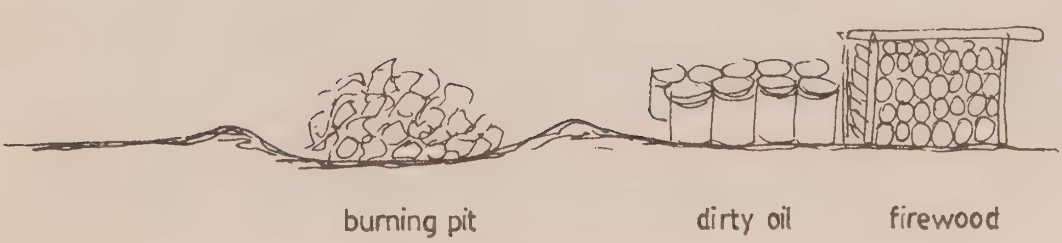


FIGURE 41 Dirty oil and firewood can be used to ensure adequate burning of garbage.

7.1.4 Landfill

Where the water table is low and there is little danger of excessive leaching, the garbage may be deposited directly in a pit and covered with a layer of soil each year.

For most sites, it is important to destroy pathogens from baby diapers that might otherwise be transported to the community water supply (either by leaching or by overland flow).

Burning of garbage and subsequent landfill is recommended.

8. ASSOCIATED APPROPRIATE TECHNOLOGIES

8.1 Air-tight Stoves and Furnaces

Most Indian homes are heated with a wood stove. Houses tend to be poorly insulated and lack an entrance vestibule.

In the winter, during the night and periods of absence, the home cools considerably.

Most homes use a 45 gallon drum as a woodstove. A hole is cut in the top of the drum. A metal pail fits in this hole and is used to heat water.

The drum is an inefficient method of heating the home. Enormous quantities of wood are burned each day to keep the house warm. Because the drums are continuously subjected to raging fires during the winter, they wear out after a few months and need to be replaced.

In some communities, a drum-like wood stove is available commercially. Because it is relatively cheap (~$40), such stoves are selected over the more efficient air-tight stoves (~ $325 to 450), even though they do not last as long.

A simple cost comparison study is required between the cheap stoves in use and the more efficient, longer lasting air-tight stoves. It is anticipated that air-tight stoves are a more economical buy in the long term. Less wood is required to provide the same amount of heat. This results in fewer skidoo trips to the forest and less gas used for the chainsaw. The life time of a solidly built air-tight stove far exceeds that of the cheap ones presently in use.

These stoves are safer and less likely to result in accidental burning of the house, a problem quite prevalent in northern communities.

Piped water supply systems are usually designed to deliver sufficient water during a fire. The cost of building a supply system with this extra capacity is exorbitant.

The money spent on putting out fires could be better spent on fire prevention. Greater fire prevention is achieved by encouraging the use of efficient well built wood stoves.

Air-tight wood stoves present a more usable surface for heating water and cooking food than drums.

Some air-tight wood stoves and most wood furnaces come equipped with a thermostat that regulates the rate of burning of the wood. Use of furnaces might be preferred in homes with small children since these units have a metal shell around the actual firebox. This metal case does not heat up as much as the actual firebox, and is less likely to injure a child if accidentally touched.

8.2 Alaska Chainsaw Mill

Most of the Indian communities within Northern Ontario occur within boreal forests (largely black spruce). Although some communities have a local mill, most rely on lumber flown in from further south.

The Alaska chainsaw is a rig that can be purchased for less than $150 in Ontario. It is used in conjunction with a heavy duty chainsaw to make rough-sawn lumber from trees.

Although black spruce is not a desirable wood for making furniture (pitch comes out of the wood and makes the surface sticky in spots), it is adequate for other uses, such as for the structural use of 2 by 4's.

The Alaska chainsaw mill is portable, inexpensive and easily operable with a minimum amount of experience.

8.3 Greenhouse

A greenhouse can be constructed of local logs or lumber and covered with polyethylene sheeting.

The purpose of the greenhouse is to extend the growing season sufficiently to start plants from seed in the spring for transplant to the community garden.

A wood furnace could be used to heat the greenhouse as necessary.

9. POLICY, ATTITUDES AND FINANCING

9.1 Policy

Although National Health and Welfare establishes water quality standards, these parameters are only guidelines, and as such are not legally enforceable. Standards are met only where local demand and economic resources permit.

Policy regarding wastewater disposal in Canada remains vague. A policy and planning report by the Water Pollution Control Directorate (1974) gives the following statement of principle:

> 'Establishment of a program of wastewater treatment for communities in Arctic and sub-Arctic regions should incorporate the following:
>
> (a) The dumping of wastewaters without appropriate treatment shall be eliminated.
> (b) The wastewater treatment provided shall be adequate to protect public health and to meet the needs of the local environment.
> (c) The quality of the receiving waters shall remain favourable to the indigenous flora and fauna.
>
> Adoption of these principles will ensure compatibility with the national objective of providing adequate sewage treatment throughout Canada.'[1]

Actual design and implementation of water supply and sanitation technologies is administered through the Department of Indian and Northern Affairs (Local Government).

In Ontario, no Water and Sanitation Section exists within the Department to deal specifically with water supply and sanitation servicing.

The situation in Northern Ontario is considerably different from that in the North West Territories.

A Water and Sanitation Section has been formed recently within the Territorial government to provide basic sanitation services subsidized within the NWT.

The Territorial Government feels that a minimum level of sanitation is necessary to promote good individual and community physical and mental health (Cameron, Appendix H, 1979).

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[1] Interim Guidelines For Wastewater Disposal In Northern Canadian Communities. Water Pollution Control Directorate, Environment Canada. 1974.

No basic standards have been set in terms of minimum water supply, sanitation and garbage servicing in Indian communities in Northern Ontario.

Generally, servicing of the Federal facilities is the primary concern of DIANA. Water supply and sanitation within the native community itself is left as the responsibility of the Band Council.

9.2 Attitudes

Because of the difficulty of establishing any clear water and sanitation policy for Indian communities in Northern Ontario, it is informative to examine attitudes expressed by various government agencies.

The quotes appearing below remain anonymous. The intent of examining them is not to malign a particular individual or department, but rather to understand the impediments in water and sanitation servicing on Indian communities.

(1) "Convenience is generally the prime consideration for remote northern communities wanting improved water and sewerage systems."

At most Indian communities, the desire for improving water and sanitation systems is based on the perception that drinking water supplies are becoming increasingly polluted.

Most Native people understand that the pollution is originating not only from non-functioning flush toilet systems at the Federal facilities, but also from the leaching of wastewater from their own outhouses.

However, Native people still attribute that the greatest amount of pollution comes from the Federal facilities.

Indian people perceive a fundamental difference in disposal practices between whites and Indians. The white people dispose of their body wastes into water; Indian people dispose of them directly onto the ground.

When drinking water supplies are perceived less desirable to drink, greater distances are travelled to get to a clean source.

Contamination of the drinking water sources (lakes and rivers) with pathogenic organisms from human feces has resulted in bacillary dysentery, salmonella and hepatitis in the Native population.

(2) "Although we are concerned with a sub-Arctic region, it is temperate zone technology that has been applied."

Repeated failures of septic tank and leaching field systems at schools on the Federal facilities demonstrate that this southern technology is not suitable for dealing with large wastewater flows in Northern Ontario.

Clayey, non-porous and frequently frozen soils do not permit easy percolation of the large quantities of wastewater generated at schools.

Clearly the danger exists of applying 'southern engineering' to northern climates without proper modifications.

An even greater danger, however, is that of applying highly complex, energy and capital intensive technologies where maintenance by experts is unlikely.

In selecting technology appropriate to the north, it is critical to design not only for climatic limitations, but also for cultural preferences.

It is important to refine our range of technologies. The distinction 'northern' versus 'southern' engineering is an extreme one.

The climate and geography of Northern Ontario permits a different range of alternatives from those in the Arctic.

Blanket application of 'northern engineering' to Northern Ontario is as meaningless as unmodified application of southern technologies.

(3) "There is not enough capital around."

Budget cuts and inflation are becoming chronic problems in our society.

Because of the scarcity of funds, it is critical that those funds available be used efficiently, and, for the benefit of the greatest number of people.

All too often, relatively little money is spent directly within the Indian community on sanitation and water servicing, while, at the same time millions of dollars are spent installing flush toilets and water taps at the schools and other federal buildings.

Essentially, a great deal of money is spent to service the non-Native segment of the community (and Native school children) while most of the community is without basic services.

Certainly the cost of servicing all members of the community at the same high standard (flush toilets and running water) is prohibitive.

However, one wonders why an intermediate level of servicing is not made available to the entire community.

School age children must find the present system schizophrenic. Between 9 and 4 o'clock they are permitted to use flush toilets and wash their hands with running water. After school, they return to a home where outhouses are used and water is hauled from outside the home.

(4) "The additional costs which result from the application of procedures appropriate in the south to the north are prohibitive."

This statement can not be denied.

However, one must ask oneself why technologies already expensive in the south (such as sewer installation) are being implemented in northern Ontario (where sewer lines frequently have to run through bedrock or swamps).

Furthermore, costs are prohibitive because premanufactured materials and outside expertise must be transported over great distances.

Bringing the technology down to a human scale would permit greater use of local human and material resources.

(5) "The short construction season requires the expeditious processing of applications and approvals. Too often the processing is delayed by consultant and bureaucratic complications. The result is that approval for projects frequently comes too late for implementation within the current construction season."

Until the very recent past, all decisions regarding water and sanitation servicing at the Federal facilities occurred outside the Indian community, and in the absence of any input from the Band Council.

Although the Band Council tends to be informed of planned improvements at present, the information is presented to the community very late in the design process.

This virtually eliminates any meaningful input by the Indian community into the design process.

When the project is finally implemented, the technically complex nature of the project requires that experienced outside people do the construction. Hence most of the salaries generated during construction leave the community.

The development of small-scale technologies comprehensible and controllable by non-experts would shift the decision-making and implementation to within the community, thereby reducing the bureaucratic complications that afflict many current large-scale water and sanitation projects in Northern Ontario.

(6) "Replanning of a settlement, including relocation of roads and houses, is, or should be, a prerequisite to construction of piped water and sewer systems. In some cases, complete relocation of a settlement may be the most economical solution for servicing the community."

Indian people traditionally do not live in a grid pattern or dense cluster.

Why adapt people to the technology? Why not adapt the technology to the people?

(7) "All pollution abatement works and related facilities should be designed by a registered professional engineer."

Sanitation and water supply problems are still viewed largely as technical problems to be solved by engineers.

Because there is a need to explore other technologies, there is a need to involve expertise from other fields such as microbiology, limnology, agriculture, silviculture, anthropology, architecture etc.

(8) " The Teacher's Union demands that water supply and sanitation conditions be similar to what teachers are accustomed to in the south."

Long-term strategy should aim for one standard of water supply and sanitation available to everyone in the community, rather than one for those on the Federal facilities and one for the Indians.

This goal is facilitated by gradually replacing the teaching and nursing positions at the communities with Native people.

(9) "Until recently, this Department (Indian Affairs) has not placed too much emphasis on the provision of infrastructure such as water and sewer services to isolated native communities. This was largely due to the amount of funding necessary, and the traditional life-style of the residents, who would often be absent from their homes for extended periods. It is now a priority of the Department that basic infrastructure be provided in a suitable form as rapidly as finances will permit and the various band leaders indicate a readiness."

In some communities, the recognition by the government to provide water and sanitation services is leading to feasibility studies and implementation of projects. Technologies put into effect still tend to be conventional and high-tech solutions.

(10) "Discrepancies exist among Indian communities in the sanitation and water supply services. The more vocal the Band in its insistence for services, the more likely the services will be supplied."

The lack of minimum water, sanitation and garbage standards results in great disequities among Indian communities.

Although some communities are in the process of receiving piped water and sewage servicing, other communities can not afford to meet even 10% of the capital cost of the total sewerage project (the other 90% is subsidized by the region).

Because the regional subsidy program is biased towards high capital, centralized systems, those communities that can and are willing to pay get a much greater influx of money and resources for sanitation and water supply than poorer communities.

The net effect is to increase disparity in servicing between wealthier and poorer Indian communities.

9.3 Financing

Great discrepancies exist in the level of water supply and sanitation servicing among Indian communities in Northern Ontario.

From Table 24 it can be seen that about 30% of the communities in northern Ontario receiving capital funding from Indian Affairs have no plan or funding set aside to upgrade present water and sanitation methods.

The total amount of capital funding to each Band is based on the number of status Indians within that Band, as well as the remoteness of that community. Total funds are usually inadequate.

In most Bands, housing is the biggest priority and receives the greatest share of capital funds. In 30% of the communities, housing and other community needs are given the highest priority, resulting in no funding left for water and sanitation.

No clear relationship exists between the size of the community and ability/willingness to allocate Band funds to water and sanitation improvements.

It is suspected that those communities with the most severe water pollution problems are most willing to make water/sanitation improvements a priority.

Once a community has allocated Band funds to water/ sanitation improvements, they become eligible for regional subsidies from Indian Affairs.

Table 25 shows the formula by which subsidies are distributed. Essentially, large scale, very expensive, centralized treatment and collection systems are subsidized to a much greater degree than small scale, low-cost local systems.

The logic for setting up such a subsidy program is clear. Because large scale centralized systems are so expensive, the government feels it must bear most of the cost of the project. Smaller scale technologies are perceived to be more affordable by the user's, and subsequently the need for subsidy is perceived to be less.

The effect of such a program, however, is to direct the selection of water/sanitation systems to ones that are very centralized, technically complex, capital and energy intensive, and non-comprehensible or controllabe by the local population.

No economic incentive exists to engage in small scale improvements (such as described in this report). For example, the subsidy formula does not list subsidies for construction of improved outhouses, composting systems etc.

Because smale scale improvements receive little or no subsidies, the disparities in water/sanitation servicing among Indian communities continue to grow.

TABLE 24 BAND ALLOCATION AND REGIONAL SUBSIDIES FOR WATER AND SANITATION PROJECTS PROJECTED FOR 1980/81 to 1984/85 (5 YEAR MANAGEMENT PERIOD)

Community	Population (1978)	Band Allocation[1] ($ 1000)	Regional Subsidy[2] ($ 1000)	% Band allocates of total capital funds to water & sanitation[3]
Angling Lake	168	0	0	0
Attawapiskat	811	174	471	13
Bearskin	273	18	103	3
Big Trout Lake	632	60	80	6
Cat Lake	253	0	20	0
Deer Lake	393	0	0	0
Fort Albany	700	134	586	12
Fort Hope	600	581	2,471	55
Fort Severn	231	7	7	1
Grassy Narrows	583	286	692	36
Islington	800	148	866	15
Kasabonika	388	0	0	0
Kashechewan	810	159	421	12
King Fisher	223	0	0	0
Lac Seul	479	20	32	3
Lansdowne	215	100	550	20
Marten Falls	125	72	338	18
Moose Factory	921	363	3,695	29
Muskrat Dam	138	0	0	0
North Spirit	225	4	4	1
Osnaburgh	600	19	19	3
Pikangikum	817	0	0	0

Community	Population (1978)	Band Allocation[1] ($ 1000)	Regional Subsidy[2] ($1000)	% Band allocates of total capital funds to water & sanitation[3]
Poplar Hill	171	0	0	0
Sachigo	222	0	59	0
Sandy Lake	1,151	387	1,163	23
Summer Beaver	211	120	605	22
Webequie	390	272	1,220	34
Winisk	253	90	470	17
Wunnummin	273	7	7	1

1 These numbers are derived from the Capital Management System submissions of each Band to the regional office (Toronto) of Indian and Northern Affairs. These numbers represent the total money the Band has allocated[from its capital (core) funds received from Indian and Northern Affairs for the next five years (1980/81 to 1984/85)] for water supply and sanitation projects.

2 These numbers are the total subsidy for water and sanitation projects provided by the region over the next 5 years.

3 These numbers show what percent of the total capital funds are allocated to water supply and sanitation improvements. These numbers indicate ability and/or willingness by the Band to pay for water supply and sanitation improvements.

TABLE 25 REGIONAL SUBSIDY FOR WATER & SANITATION

To provide 90% subsidy on the following items (TREATMENT):

(1) water intakes
(2) water treatment plants
(3) water pumping stations
(4) water reservoirs on distribution system
(5) sewage treatment plants and lagoons
(6) treated sewage discharge lines
(7) sewage force mains
(8) sewage lift stations

To provide 70% subsidy on the following items (COLLECTION):

(1) community water distribution systems
(2) community sewage collection systems
(3) Septic systems only in planned community housing areas serviced by a community water distribution system
(4) vehicles for water delivery or sewage collection

To provide 50% subsidy on the following items:
(SMALL SCALE ON-SITE SYSTEMS)

(1) Community wells, pumping and treatment facilities only where used with a water distribution system servicing a planned community housing area
(2) wells and associated pumping facilities in rural and sparsely populated areas
(3) septic systems and holding tanks in rural and sparsely populated areas
(4) sanitation incentive programs

Source: Distribution of Local Government Capital Funds in Ontario Region (revised February 1, 1979) Indian and Northern Affairs, Toronto, Ontario.

10. RECOMMENDATIONS

(1) SET UP A MORE DEFINITE AND EFFECTIVE WATER AND SANITATION POLICY

This policy should ensure that every community is fully involved in any improvements to be undertaken, and that this involvement occur early in the design process.

The policy should strive for one standard of water and sanitation servicing, rather than the present one standard for non-Natives and one for Native people.

The existing government should encourage the designing and testing of new approaches to water supply and sanitation, particularly those meeting the criteria of an'appropriate technology'.

(2) SET UP MINIMUM WATER SUPPLY AND SANITATION STANDARDS

This is required to ensure greater equity among remote Indian communities in achieving adequate sanitation and clean water supplies.

(3) ESTABLISH FEASIBILITY OF A CENTRAL FACILITY (LAUNDRY/ SHOWER FACILITY) IN EACH COMMUNITY

As part of the feasibility study, it is critical that the idea is introduced to the community, and that the community is encouraged to express its needs and desires.

(4) PREPARE AND DISTRIBUTE A SLIDE SHOW CONCERNING APPROPRIATE TECHNOLOGY AS IT APPLIES TO WATER AND SANITATION

Before any changes and improvements can be effective, it is critical that local residents desire those improvements.

To help residents choose those improvements that are appropriate to their lifestyle, compatible with the environment and safe from a health view point, as well as affordable, residents require sufficient information to make an intelligent choice.

To ask if they desire flush toilets is to ask a question in a vacuum. They may want the flush toilet, but not want the associated costs, breakdowns and permanence of such a system.

Each choice they make should be done with full knowledge of the economic, social and environmental consequences of that choice.

Preparation of a slide show indicating possible alternatives and constraints of water supply and sanitation systems would begin the information flow upon which an informed decision can be made.

(5) SET UP AN EXPERIMENTAL DRUM PRIVY SYSTEM

There is a need to establish if complete decomposition can be achieved within a drum privy in a summer in northern Ontraio, if supplemented by passive solar heating.

It is important to verify that pathogens within the composted feces can be destroyed with such solar pasteurization.

An experimental setup in southern Ontario in the late spring or early fall could simulate summer climate conditions in northern Ontario. Setting up the experiment in southern Ontario permits easy access to microbiological testing laboratories for analysis of pathogens.

(6) PILOT PROJECT IN A NORTHERN INDIAN COMMUNITY

In setting up a pilot project in an Indian community, great benefit can be derived by sponsoring some Indian people from other Bands to take part in the pilot project.

This facilitates faster transmission of knowledge, and a wider participation in finding solutions.

(7) RE-INVESTIGATE SUBSIDY PROGRAM

The present subsidy program is biased towards high-cost complex distribution, collection and treatment systems.

Provision should be made to amply subsidize small-scale appropriate technologies so as to make them more attractive as water/sanitation alternatives.

(8) INVESTIGATE SUBSIDIES FOR AIR-TIGHT WOOD STOVES AND FURNACES

The Canadian Home Insulation Program (CHIP) operates on the principle that providing an incentive to individuals to prevent excessive heat loss from their homes contributes to the benefit of all in the long term by reducing the rate of fuel depletion.

A similar argument can be made for providing economic incentives to Native people to use more efficient wood stoves and furnaces. A moderate investment now will provide greater overall benefits in the future.

Bibliography

1. Asdor Ltd. BioDisc: The Complete Sewage Process. Publication 112. Downsview, Ontario.

2. Bennett, E.R. et al. "Rural Home Wastewater Characteristics" In: Home Sewage Disposal Proceedings of the National Home Sewage Disposal Symposium ASAE, 1974.

3. Brown, R.J.E. Permafrost Investigations in Northern Ontario and Northeastern Manitoba National Research Council of Canada. Ottawa 1968.

4. R.J.Burnside and Associates. Sewage Management Study at Fort Hope Indian Reserve. For EPS Environment Canada. 1975.

5. Cameron, J.J. "Information Provided by Northern Technology Unit" Environmental Protection Service, Edmonton Appendix II (1979) to User's Making Choices. T.Jackson et al, 1978.

6. Cameron, J.J. and B.Armstrong. Water and Energy Conservation Alternatives for the North. Prepared for Symposium on Utilities Delivery in Northern REgions, Edmonton. EPS Environment Canada, 1979.

7. Canadian British Engineering Consultants. Study of Solid Waste Management at Indian Settlements in Northern Ontario. Produced for EPS Environment Canada, 1975.

8. Crysler & Lathem Ltd. Feasibility Study of Municipal Services at Fort Albany Indian Reserve. For Department of Indian-Inuit Affairs, Ontario Region. 1979.

9. Dominion Soil Investigation Ltd. Soil Investigation: Proposed Sewage Disposal and Treatment Facilities, Sandy Lake Indian Reserve. For EPS Environment Canada, 1976.

10. Environment Canada. Canadian Normals: Temperature (1941-1970) Downsview, Ontario 1975.

11. Environment Canada. Canadian Normals: Precipitation (1941-1970) Downsview, Ontario 1975.

12. Goldstein, S and W.Moberg Wastewater Treatment Systems for Rural Communities. Commission on Rural Water, Washington D.C. 1973.

13. Golueke, C.G. Biological Reclamation of Solid Wastes. Rodale Press, Emmaus, Pennsylvania 1977.

14. Golueke, C.G. Composting: A Study of the Process and its Principles. Rodale Press Inc. Emmaus, Pennsylvania 1972.

15. Gotaas, H.B. Composting: Sanitary Disposal and Reclamation of Organic Wastes World Health Organization Monograph Series No. 31 Geneva, Switzerland, 1956.

16. Henry, J.G. "Psychrophiles in Waste Treatment" In: Symposium on Wastewater Treatment in Cold Climates Water Pollution Control Directorate, Environment Canada 1974.

17. Indian and Northern Affairs Department Reference Manual 1979.

18. Interprovincial Conference of Ministers with Responsibility for Northern Development. Housing and Related Technology for Sewer and Water. Sault Ste Marie, Ontario 1979.

19. Jackson, T. et al. User's Making Choices: First Technical Report of the Big Trout Lake Sewage System Environmental Assessment. Big Trout Lake Band Council and Participatory Research Project, International Council for Adult Education, Toronto, 1978.

20. K.H.King Associates Ltd. Soil Conditions-Proposed Subdivision Moose Factory Island. Report to Ontario Ministry of Treasury Economics and Intergovernmental Affairs, 1975.

21. Laak, R. Home Plumbing Fixture Waste Flows and Pollutants. University of Connecticut, Storrs, 1972.

22. Ministry of Health, Viet Nam. Viet Namese Double Septic Tanks. Department of Epidemiology, Ministry of Health, Viet Nam 1968.

23. Ministry of Natural Resources. Climate of West Patricia Planning Area, Ontario 1978.

24. Ministry of Northern Affairs. Northern Ontario Directory 1979/1980. Ontario

25. McGarry, M.G. and J.Stainforth. Compost, Fertilizer and Biogas Production from Human and Farm Wastes in the People's Republic of China. International Development Research Centre, Ottawa, 1978.

26. Nelson, L and J.Yudelson. Criteria for an Appropriate Technology. Office of Appropriate Technology. State of California. Governor's Office. Office of Planning and Research.

27. Office of Appropriate Technology. Rural Wastewater Disposal Alternatives. Final Report Phase I. State of California Governor's Office. Office of Planning and Research 1977.

28. Ophuls, W. Ecology and the Politics of Scarcity W.H.Freeman and Company, San Francisco, 1977.

29. Pond, C.E. and R.W.Crites. "Nationwide Experiences in Land Treatment" In: Proceedings of the Conference on Land Disposal of Municipal Effluents and Sludges. Rutgers USEPA 1973.

30. Proctor and Redfern Ltd. Grassy Narrows Sewage Treatment Facilities. For EPS Environment Canada, 1974.

31. Proctor and Redfern Ltd. Sachigo Lake Indian School Sewage Treatment Facilities. For: EPS Environment Canda, 1974.

32. Royal Commission on the Northern Environment. Issues Report 1978.

33. Rybczynski, W. "Improved Outhouse Plus Liner" Appendix F to User's Making Choices T.Jackson et al 1978.

34. Rybczynski W and A Ortega. Stop the Five Gallon Flush! Minimum Cost Housing Group, School of Architecture. McGill University, Montreal 1973.

35. Siegrist, R. Segragation and Treatment of Black and Greywaters. Small Scale Waste Management Project. University of Wisconsin, Madison, 1976.

36. Stoner, C.H. (Ed.) Goodbye to the Flush Toilet Rodale Press, Inc. Emmaus, Pennsylvania 1977.

37. The UMA Group. Report on Waste Disposal for Lansdowne House. For: EPS Environment Canada, 1972.

38. The UMA Group. Sewage Report for King Fisher Lake School. For: EPS Environment Canada, 1974.

39. Van der Rym, S. The Toilet Papers Capra Press, Santa Barbara, 1978.

40. W.L.Wardrop and Associates Ltd. Sandy Lake Indian Reserve Nurse's Station Sewage Disposal System Improvements. For: EPS Environment Canada, 1973.

41. W.L.Wardrop and Associates Ltd. Poplar Hill Indian Reserve: Indian School Sewage Disposal System Improvements. For EPS Environment Canada, 1974.

42. W.L.Wardrop and Associates Ltd. Improvements to School Sewage Disposal System Webequie Indian Village. For: EPS Environment Canada, 1974.

43. W.L.Wardrop and Associates Ltd. Deer Lake Indian School Sewage Disposal System Improvements For: Indian and Northern Affairs, 1975.

46. Water Pollution Control Directorate. Interim Guidelines For Wastewater Disposal in Northern Canadian Communities. EPS Environment Canada.

47. Water Pollution Control Directorate. Composting Toilets and Greywater Systems: A Critical Guide to their Application and Operation In Canada (draft) EPS Environment Canada 1979.

48. Water Pollution Control Directorate. Cold Climate Utilities Delivery Manual. Economic and Technical Review. Report EPS #-WP-79-2. Environment Canada 1979.

49. Woodwell, G.M. Recycling Sewage Through Plant Communities. American Scientist Volume 65, 1977.

50. Yudelson, J. and S.Van der Rym. What is Appropriate Technology? Office of Appropriate Technology, State of California, Governor's Office, Office of Planning and Research. 1977.

51. Zimmerman, A.P. "Winter Water Quality Tests, Phosphorus Loading Regimes, Bay Flushing, The Interim Sewage Solution and Proposal for a Wetland Construction Project". Appendix E (1979) to User's Making Choices T.Jackson et al, 1978.